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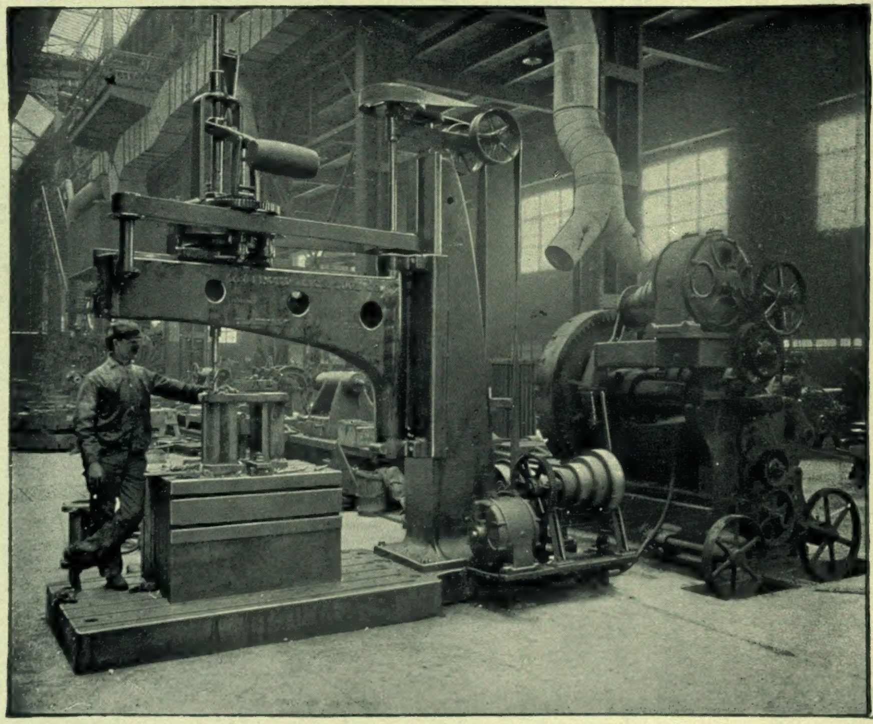

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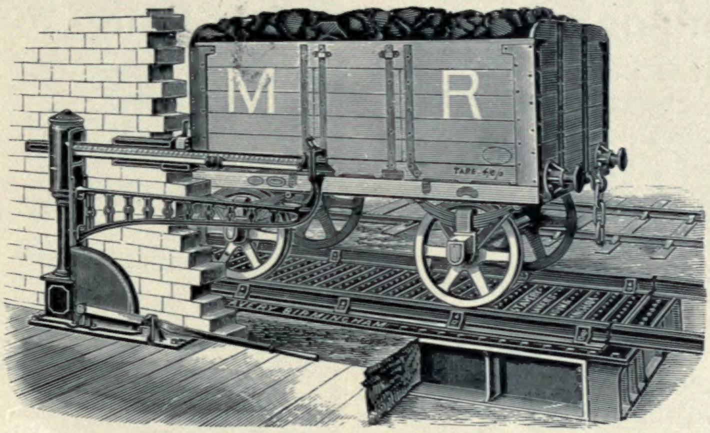

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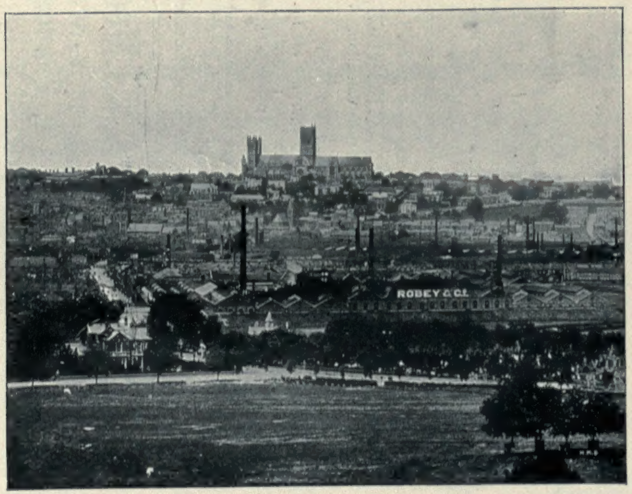

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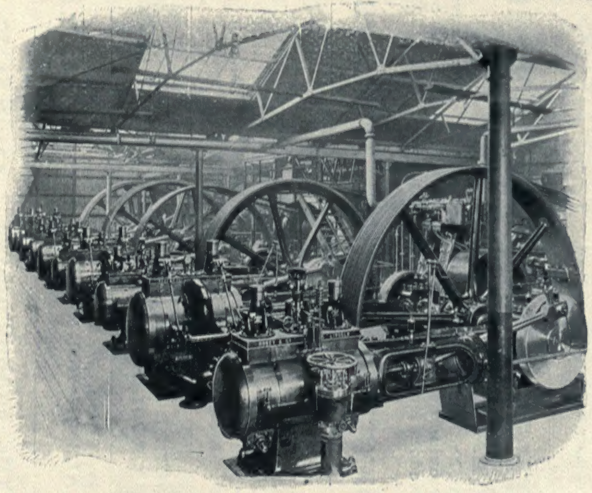

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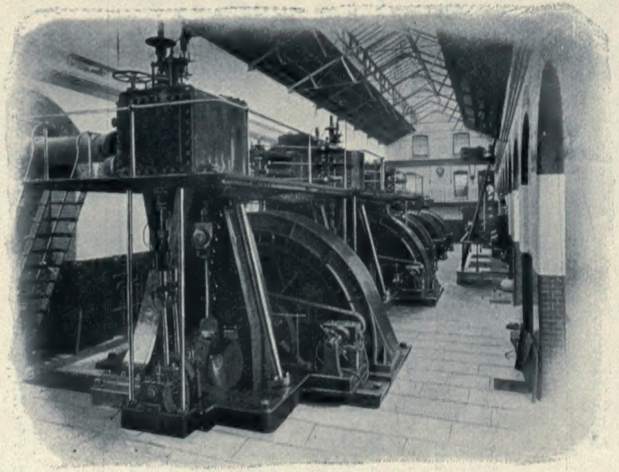

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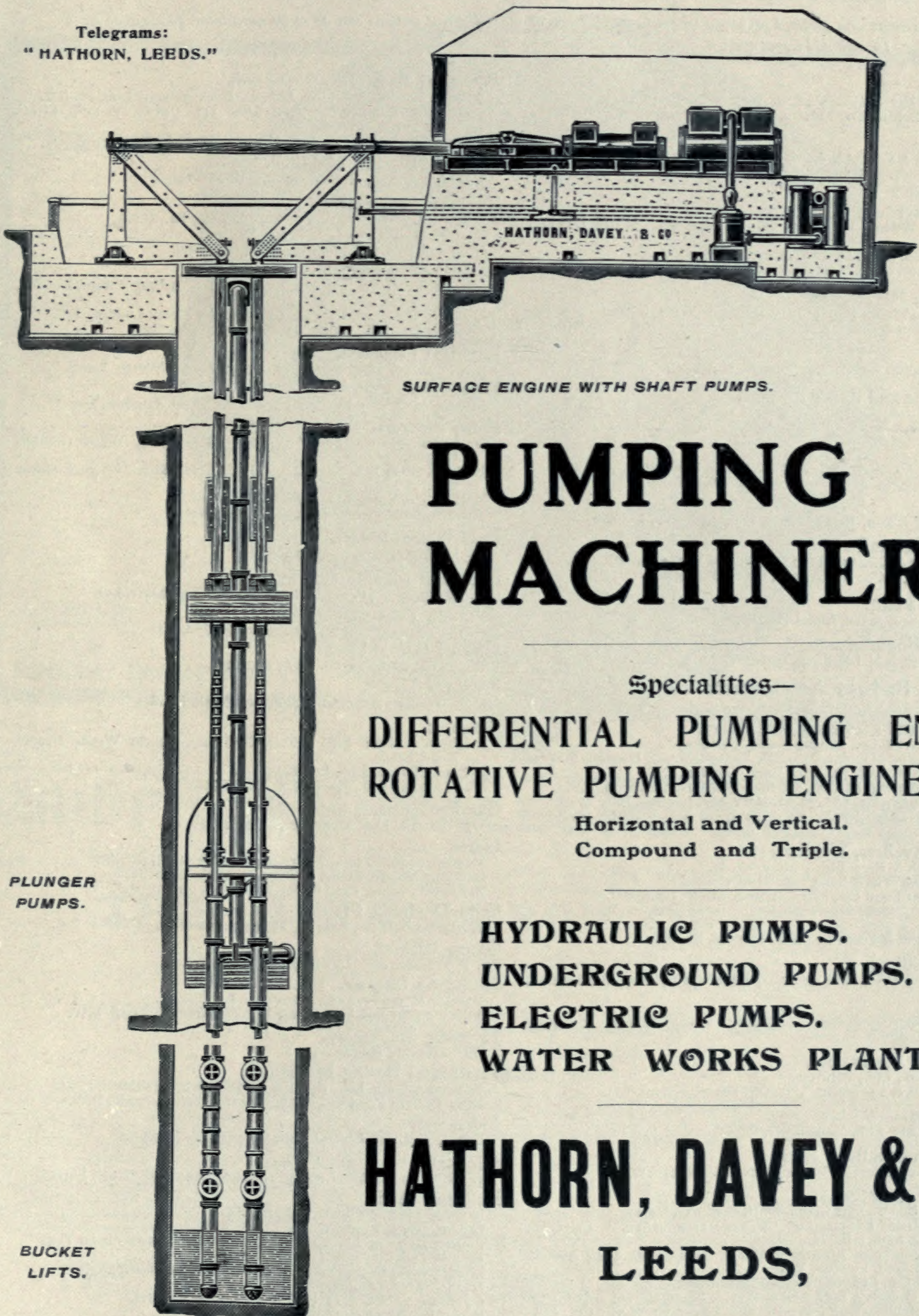

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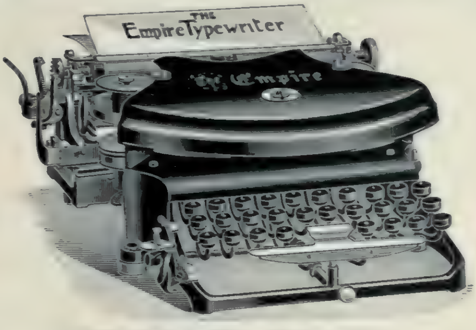

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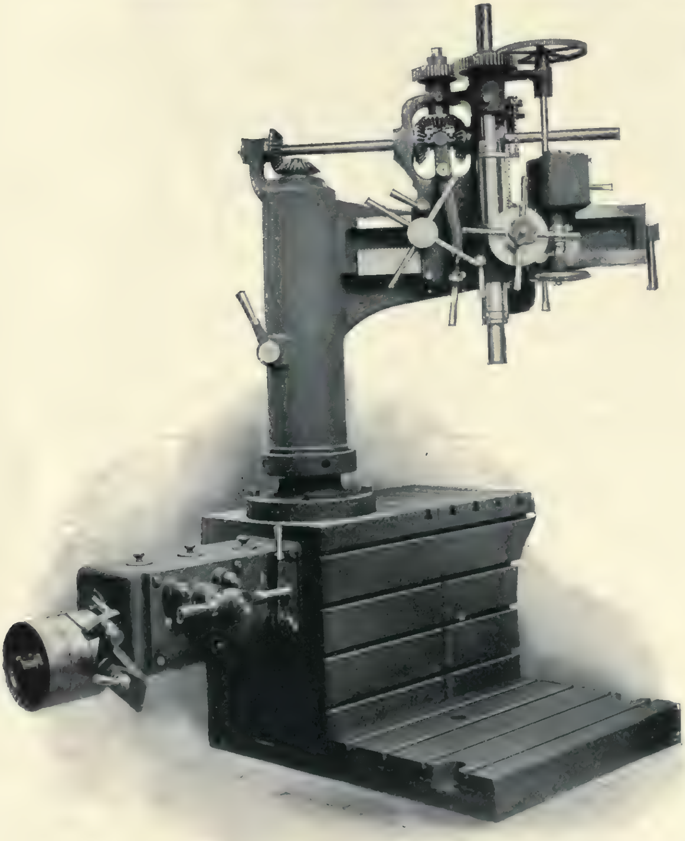

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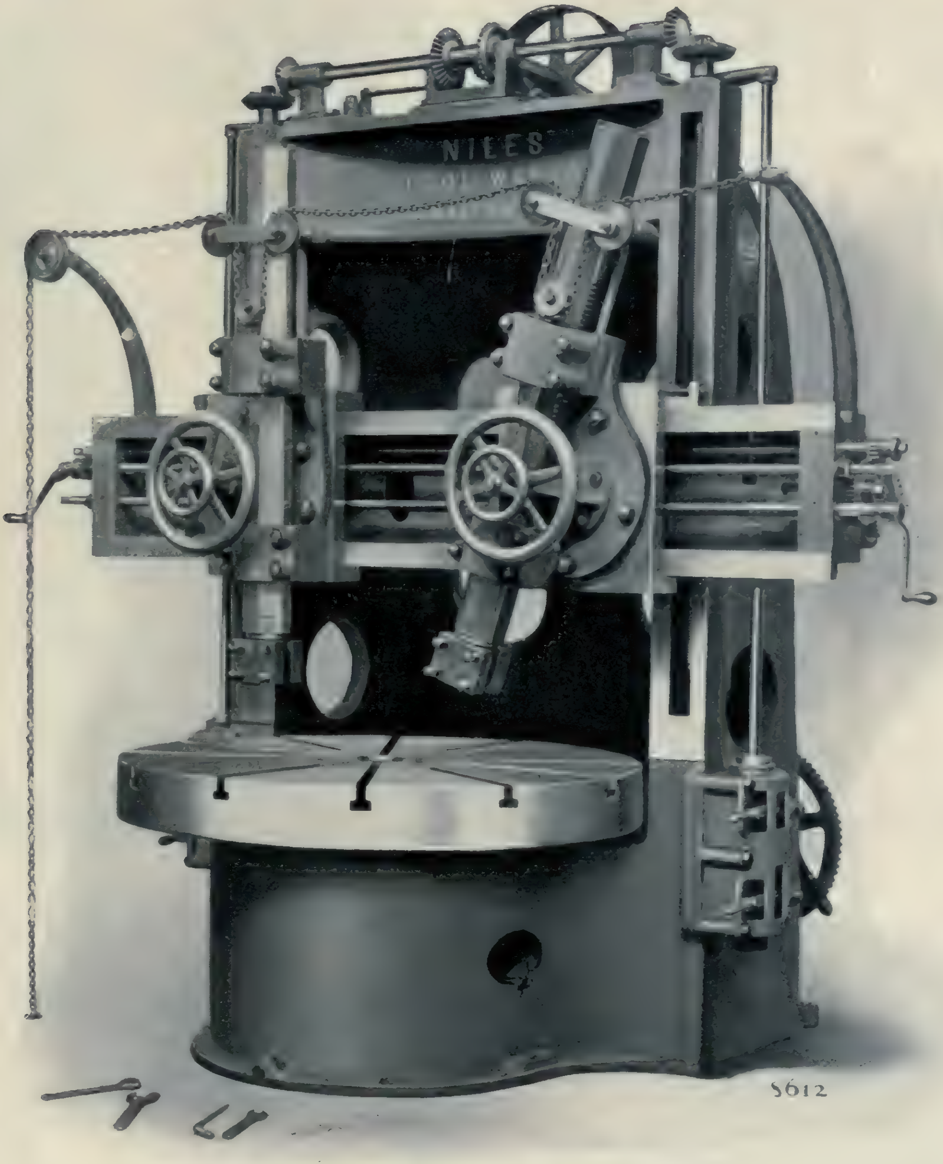

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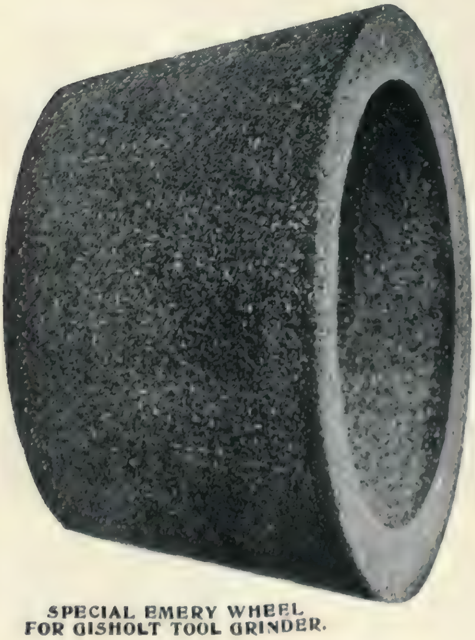
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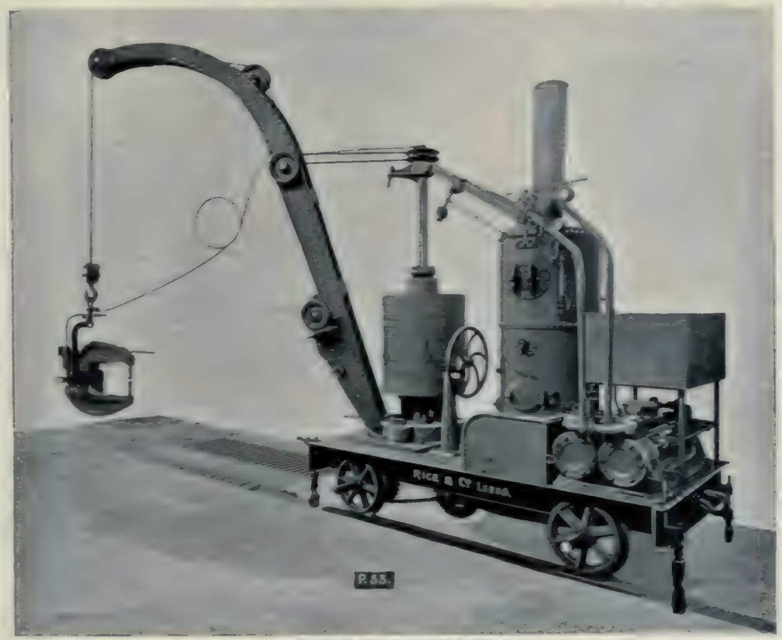

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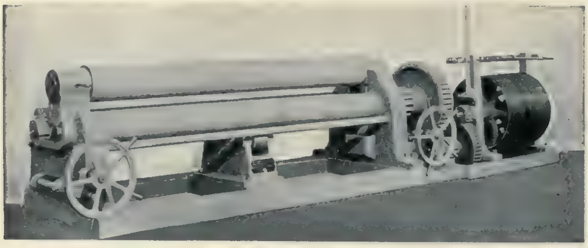

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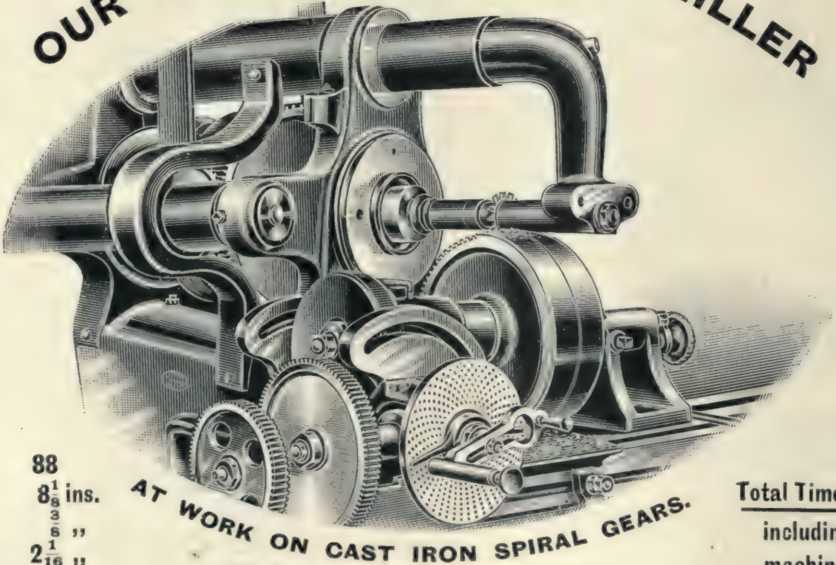

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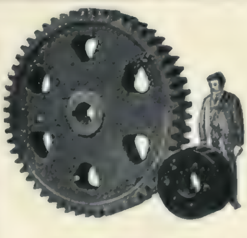

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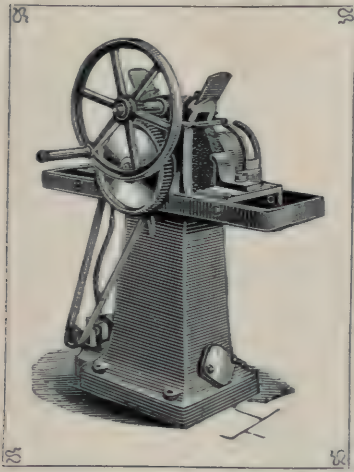

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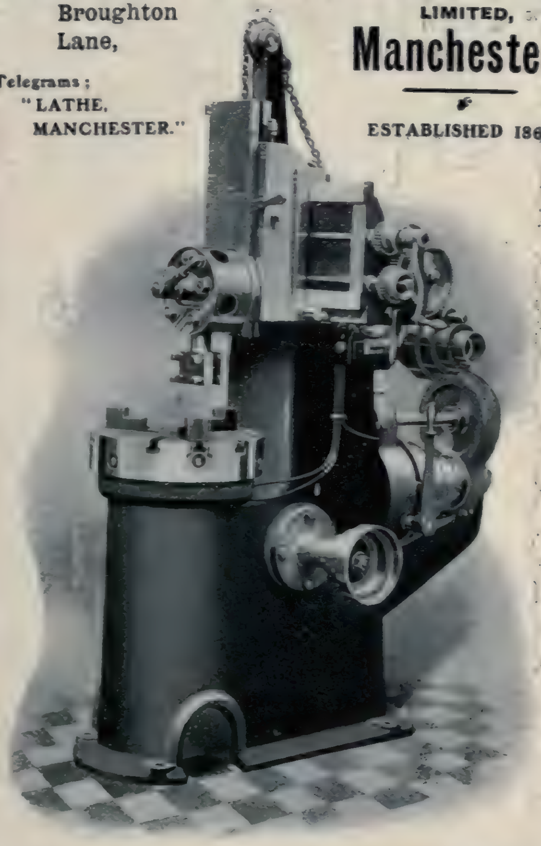

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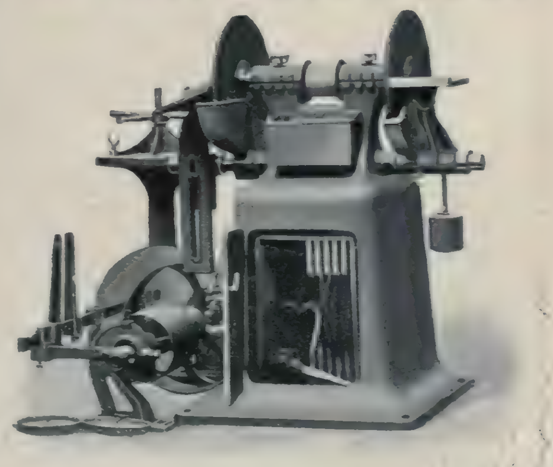

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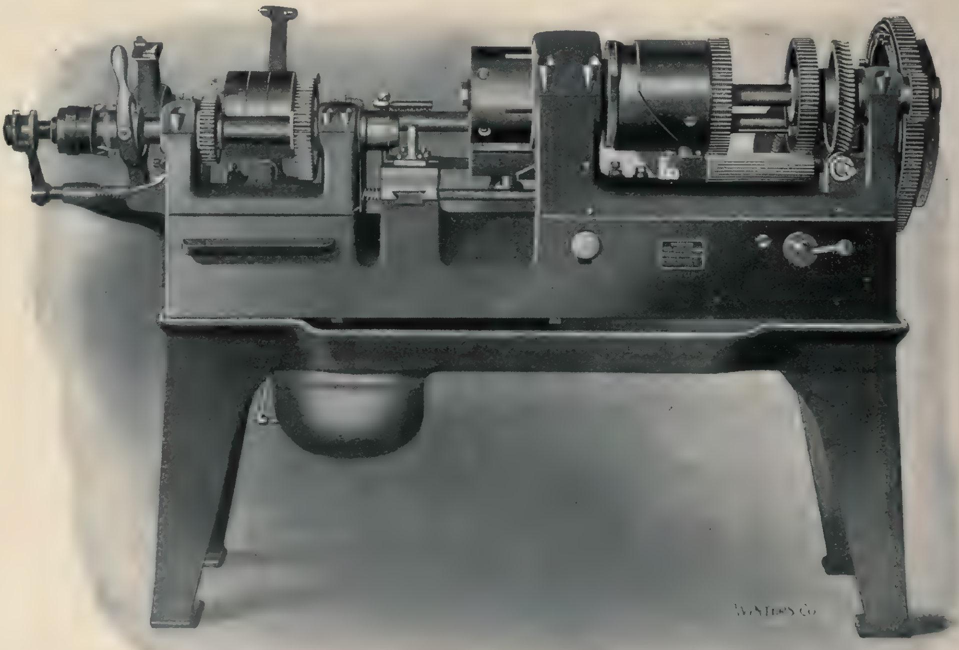

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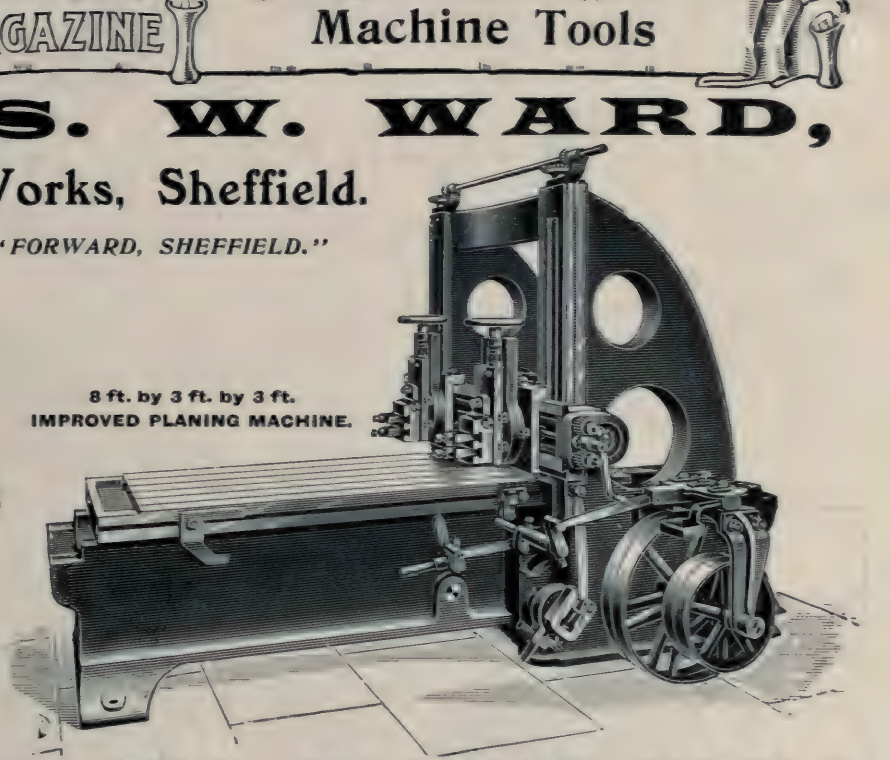

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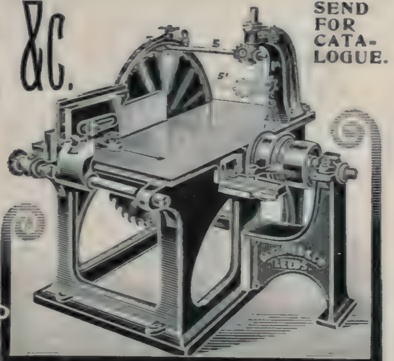

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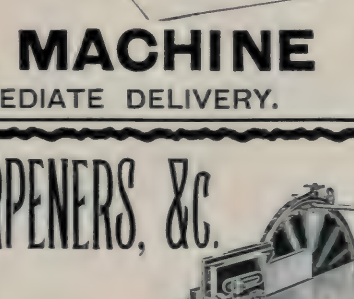

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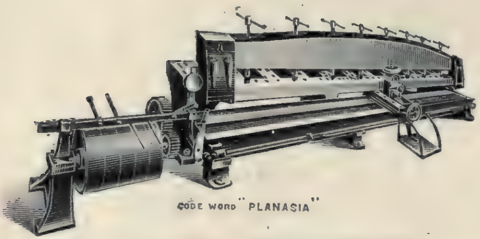

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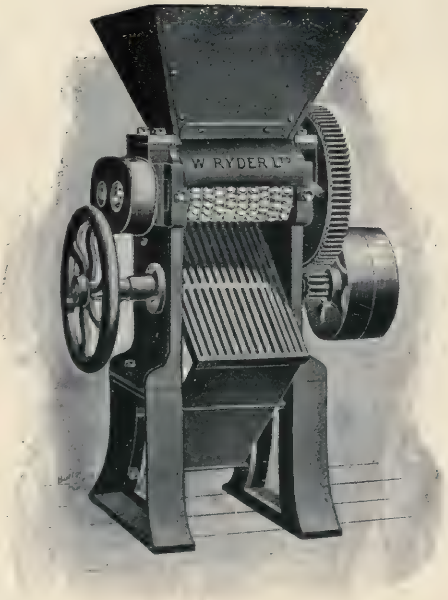

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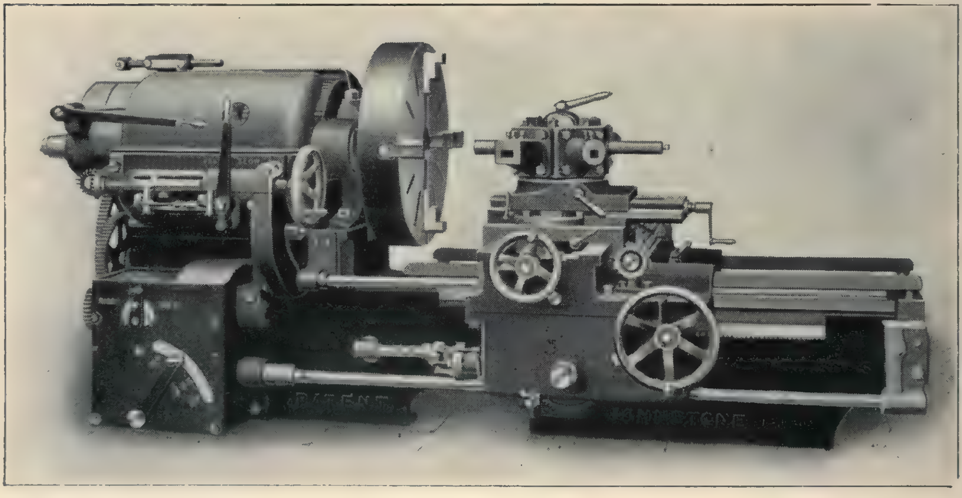

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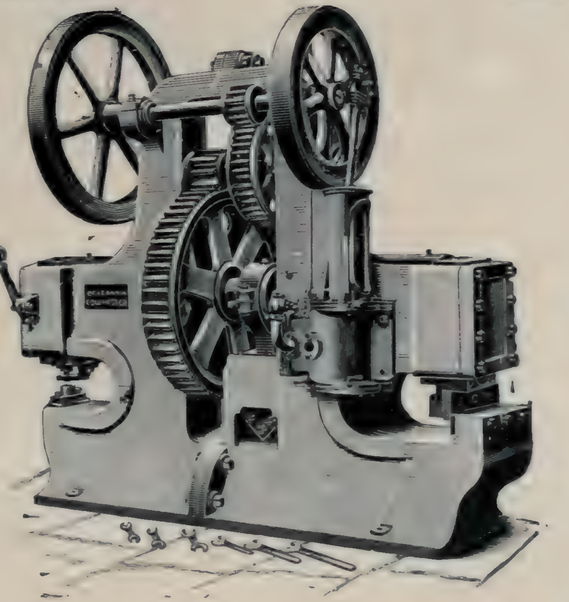

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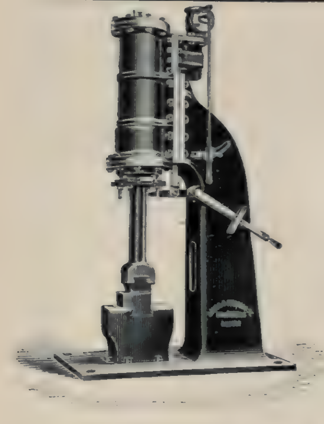

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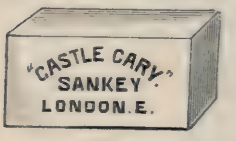

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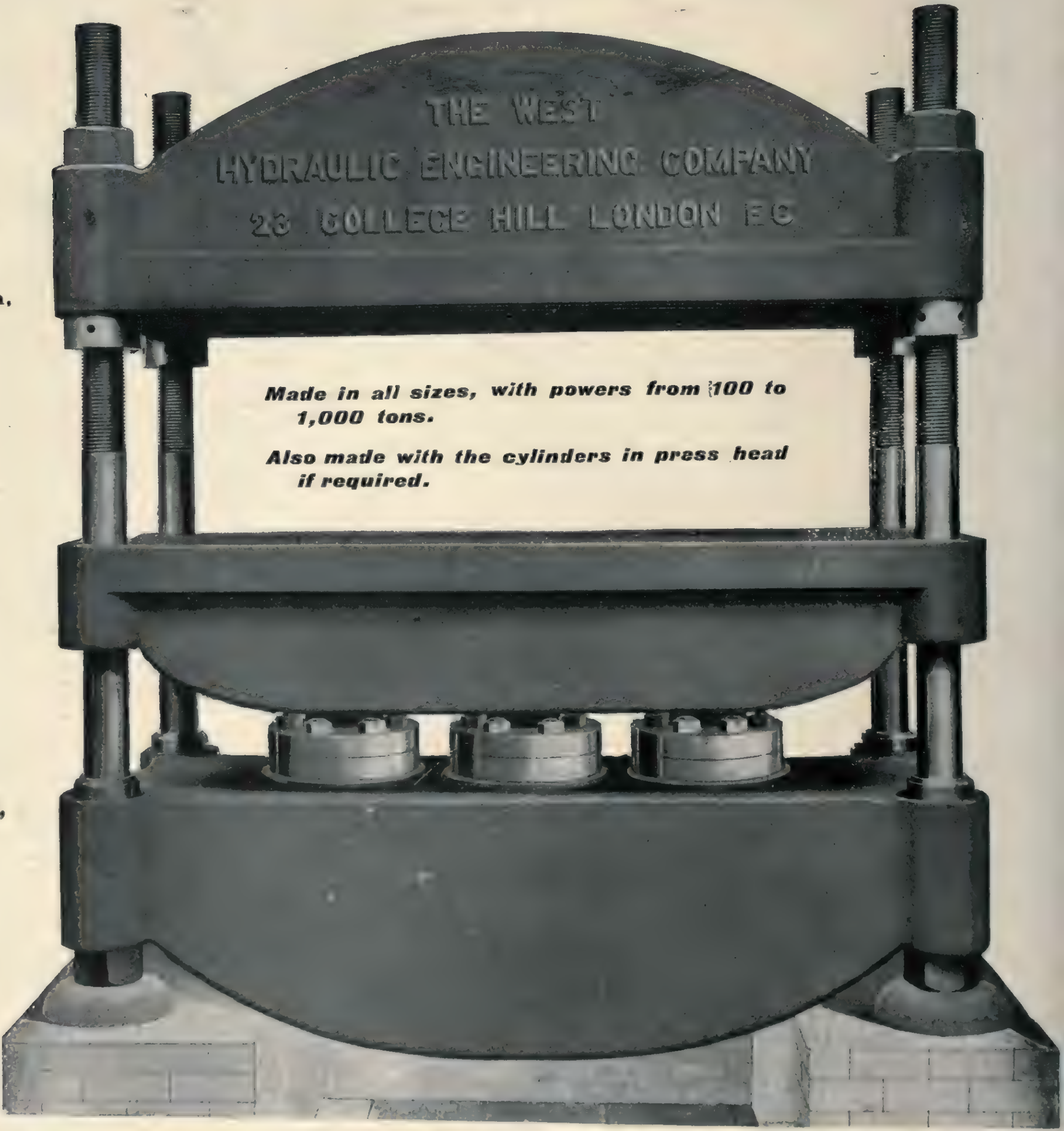

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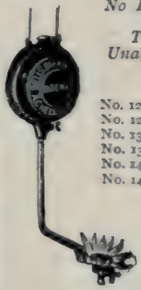

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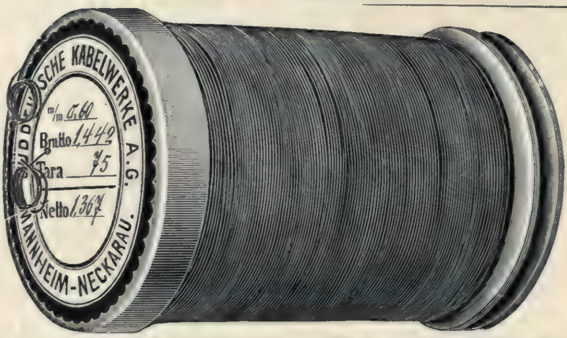

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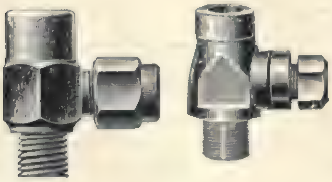

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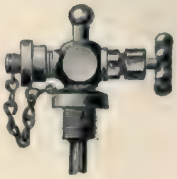

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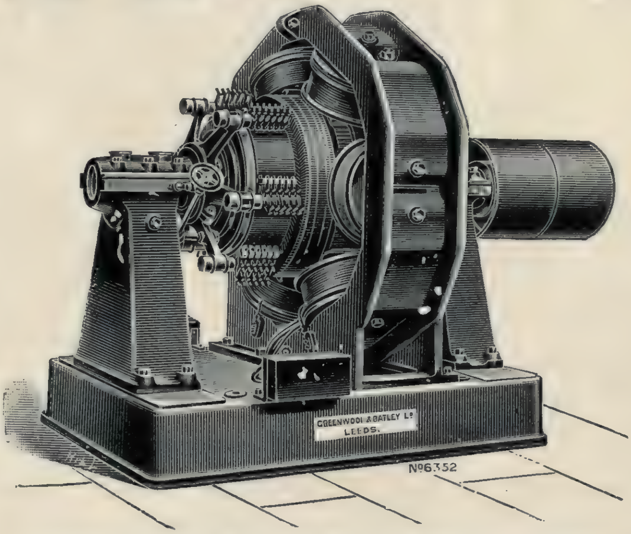

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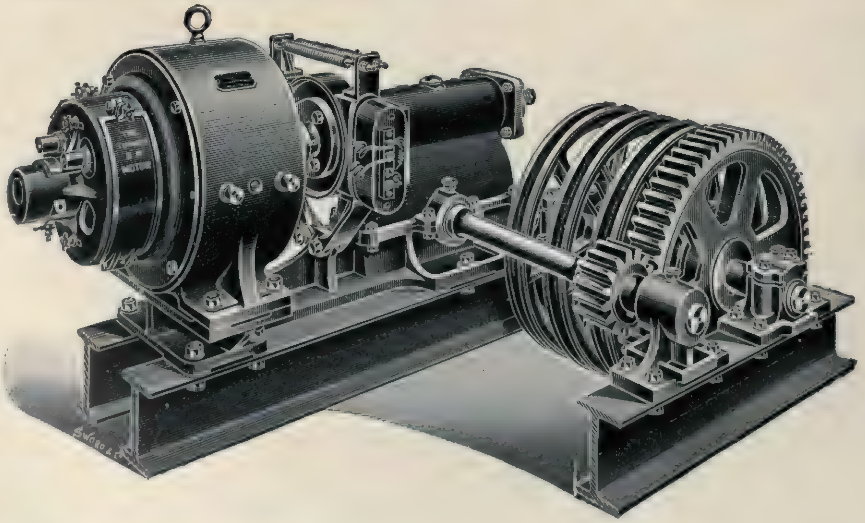

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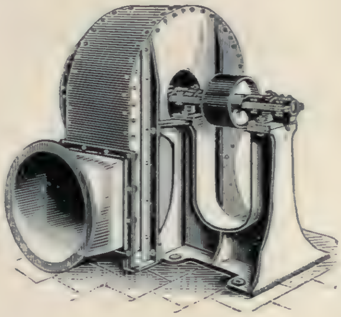

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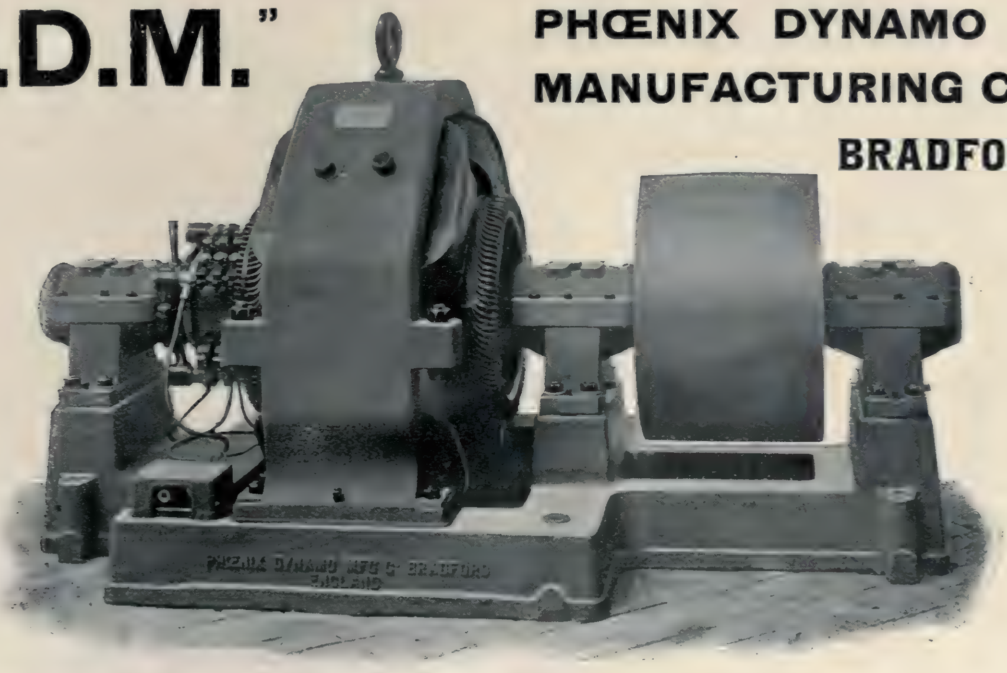

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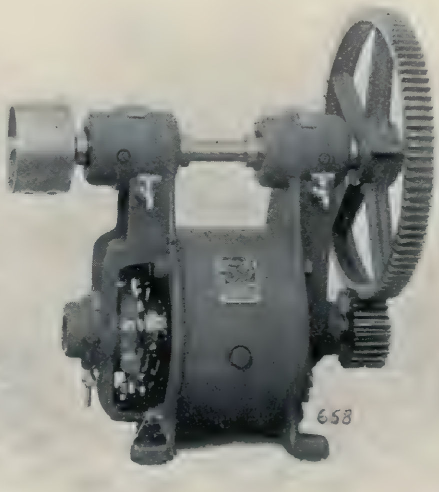

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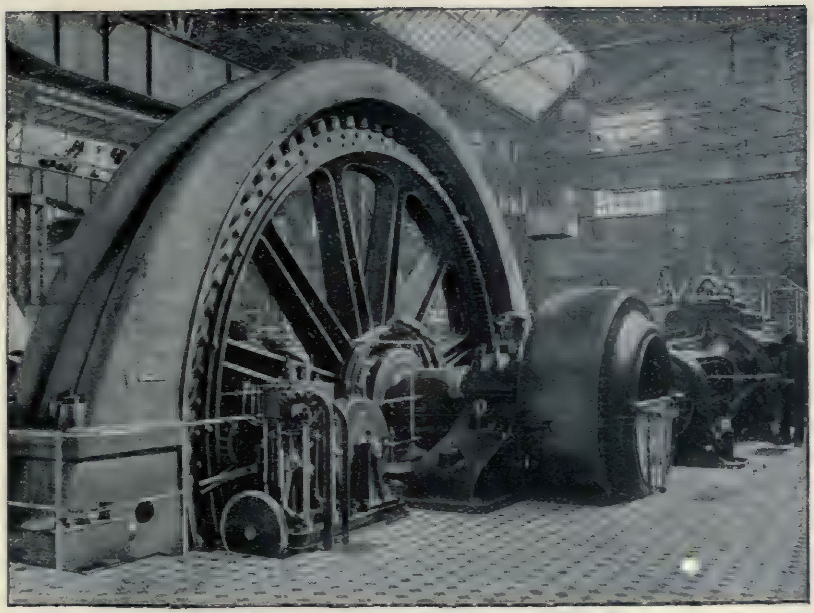

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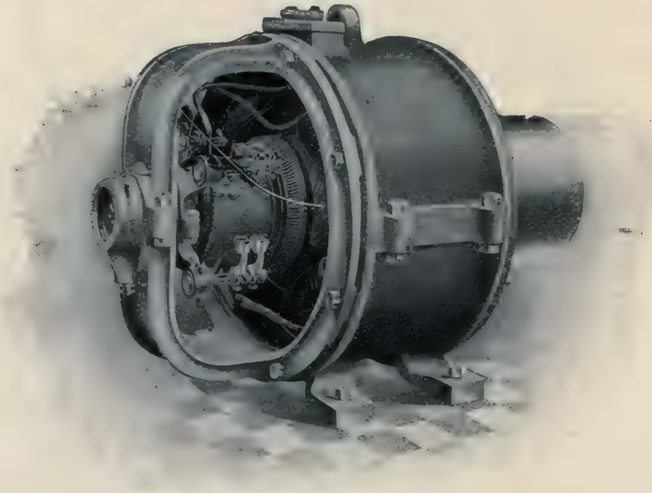

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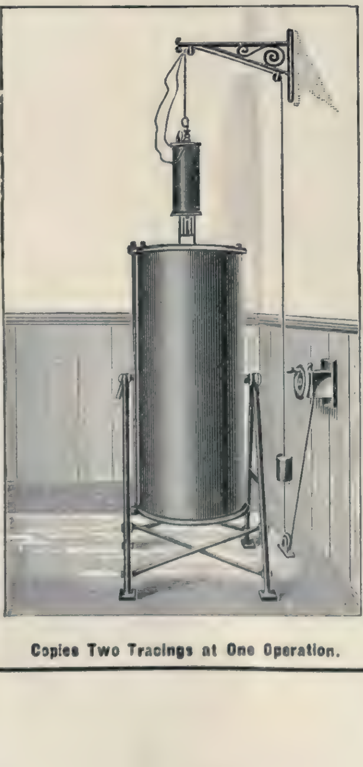

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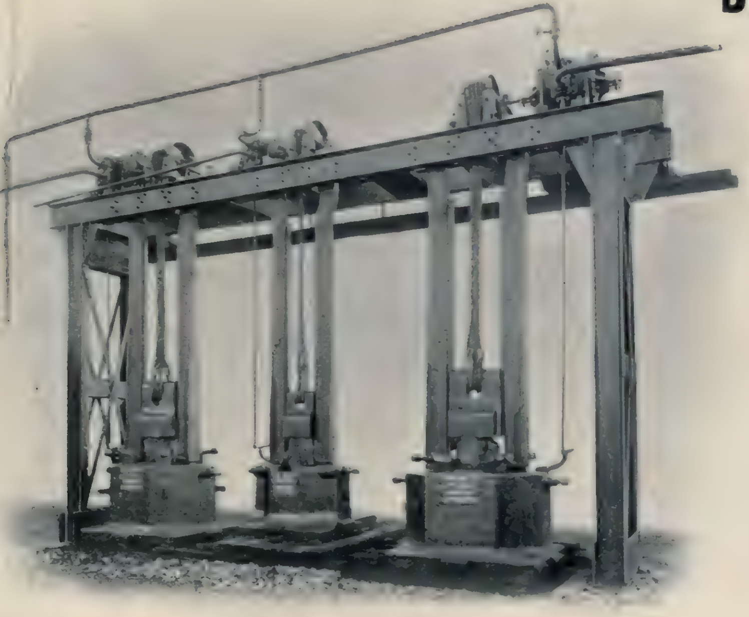

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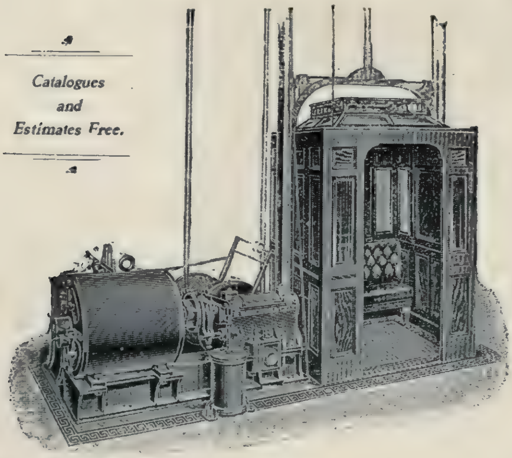

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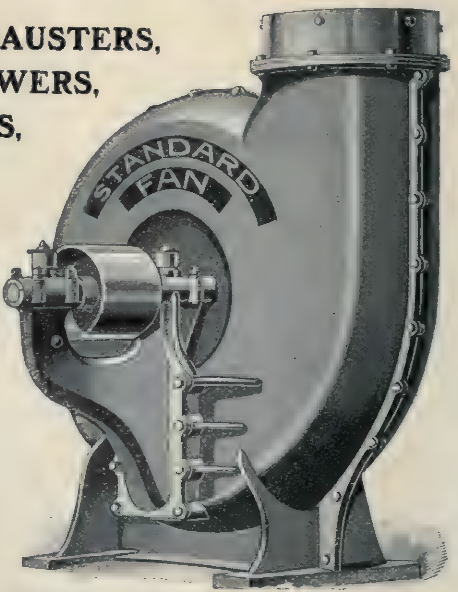

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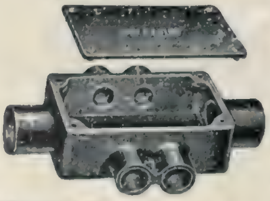

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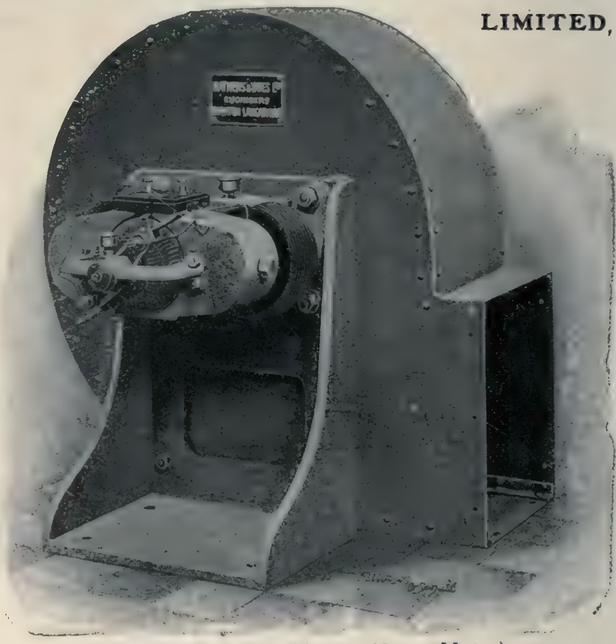

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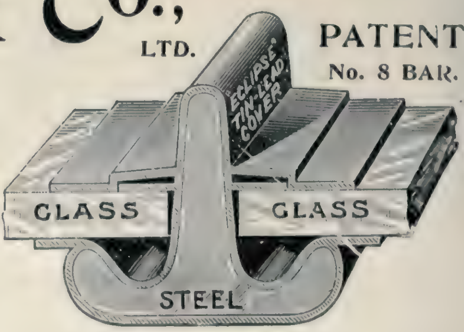

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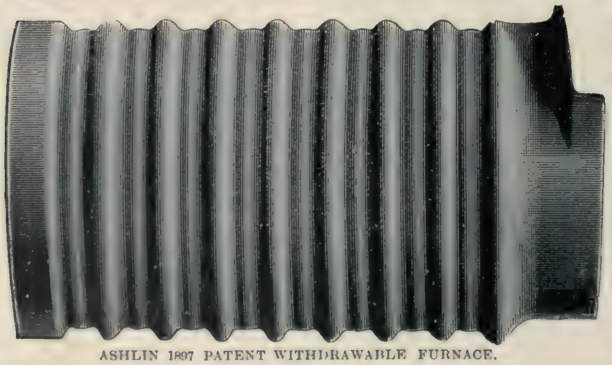

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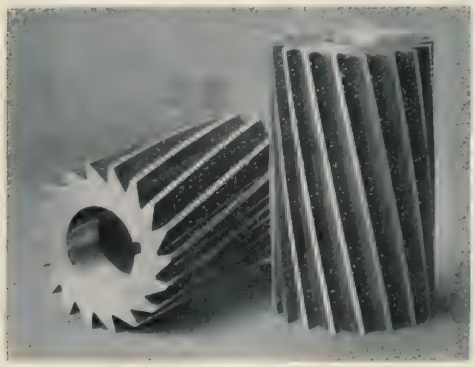

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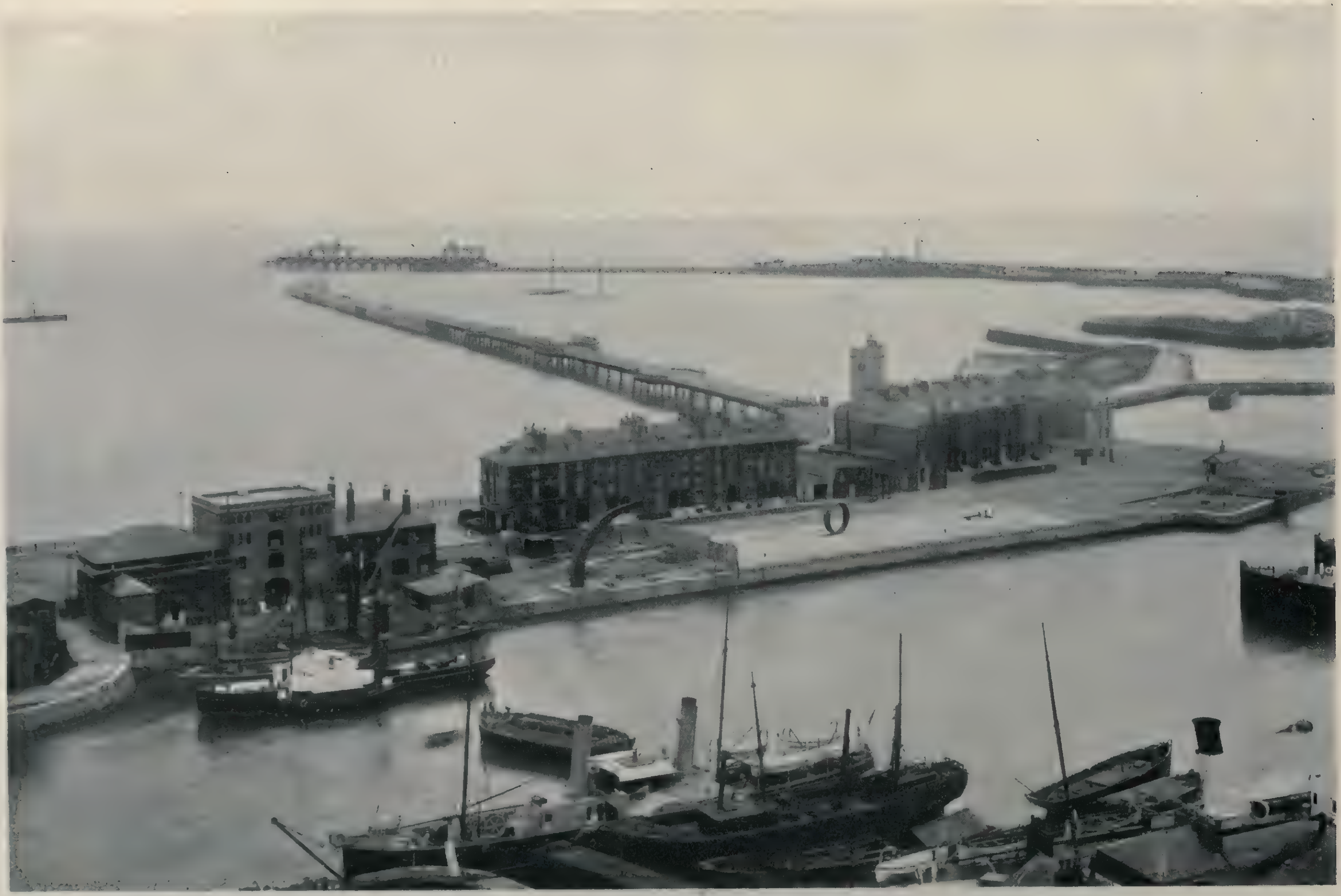

THE ADMIRALTY PIER EXTENSION, AND PRINCE OF WALES PIER AT DOVER.

For "A British Naval Station of the Future," see page 129.

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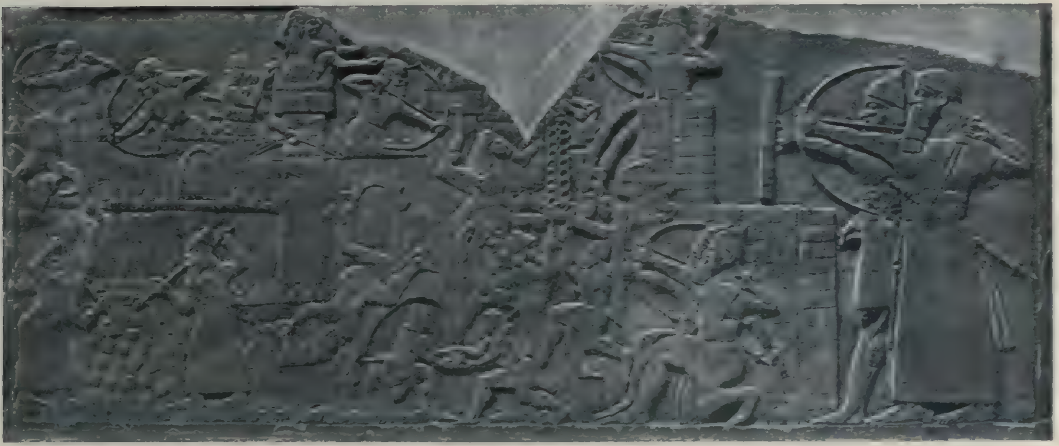


FIG. 8. A WALL SCULPTURE FROM THE NIMRUD GALLERY, BRITISH MUSEUM, IN WHICH MAY BE SEEN A BATTERING RAM AND A CHAIN TO DESTROY THE ACTION OF THE RAM.

THE EVOLUTION OF THE CHAIN.

BY

J. HARTLEY WICKSTEED,

President of the Institution of Mechanical Engineers.

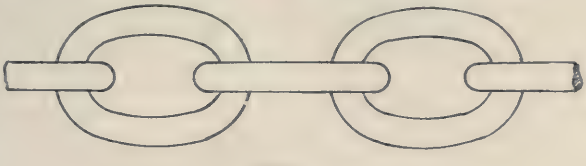
The author traces the evolution of the chain from primitive ages, discusses its various developments in modern times, and includes a unique collection of illustrations.—ED.

TWO PRINCIPAL FORMS.

THERE are two principal forms of construction in chains which we shall find have run through all the ages of chain-making from the earliest recorded times of the human race up to the latest moment in which we live.

The first and most important type is that of a chain constructed of a series of rings, interlinking with each other, so that they cannot come apart without being cut or broken. Each ring is constructed so as to pass through the rings which are next to it, as shown in the sketch of type No. I.

The second type of chain is also composed primarily of rings, but no ring passes through another, and the chain can be taken to pieces without being broken. It is put together by bending each ring till it forms a double loop, and the next ring passes through the loop so



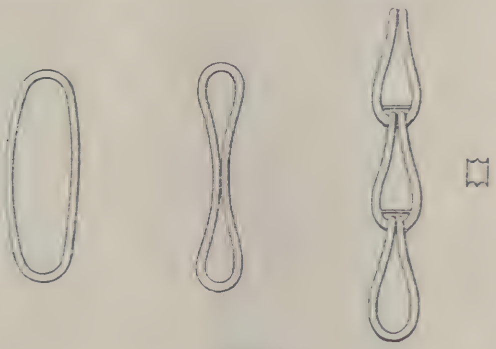
TYPE I.

Photo by Elliott and Fry.

J. HARTLEY WICKSTEED, ESQ.,

President of the Institution of Mechanical Engineers.

formed, but does not pass through the circle of the ring at all. The rings do not interpenetrate each other, and consequently this chain can be easily made, as the primary rings of which it is composed require no jointing by welding or otherwise, but can be beaten out of a solid piece, as shown in the sketch of type No. II.



TYPE II.

THE ANTIQUITY OF CHAIN-MAKING.

A chain then consists essentially of links or rings connected in a series by interlacing with each other. Ornamental chains are often made of vegetable fibre, of hair, and of gold, and as the earth produces all these materials in their native state, it is possible that such chains were constructed long before chains of silver or brass, or iron. On the other hand, they may possibly have followed after chains of metal as a mere imitation for ornamental purposes. "Necessity is the mother of invention," and to make a flexible band of strong metal the invention of links becomes necessary, whereas flexible bands could be made of grasses without that invention.

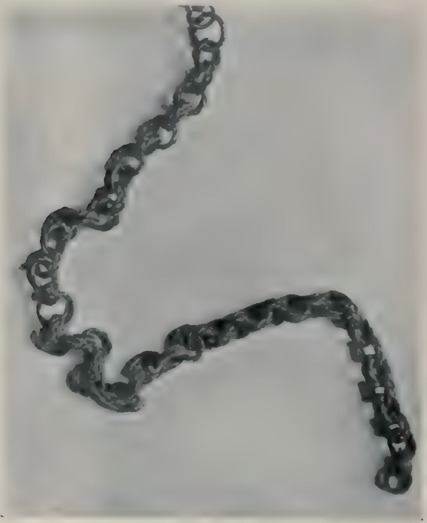


FIG. I. A PLAITED INDIAN CHAIN MADE OF CIRCULAR LINKS FROM FINE SHREDS OF BAMBOO.

Fig. 1 shows a chain made in India of circular links plaited of fine shreds of bamboo. It is a necklet, and purely for ornament, but it has the same principle of construction as metal chains of type No. I.

The ingenuity of making these interlacing rings does not strike one as being so far removed from the ingenuity of other bipeds than man (the weaver bird for example), as the metallurgical processes of reducing ore by fire, and the welding of iron, or casting of silver and bronze; and, from this point of view, grass chains may have been invented by primitive man merely from the love of ornament, and without the stimulus of necessity, especially as a catenary curve is such a graceful thing for ornament and for comfort in wearing. If this be so, the antiquity of such chain-making in grasses may be almost that of man himself, who has left

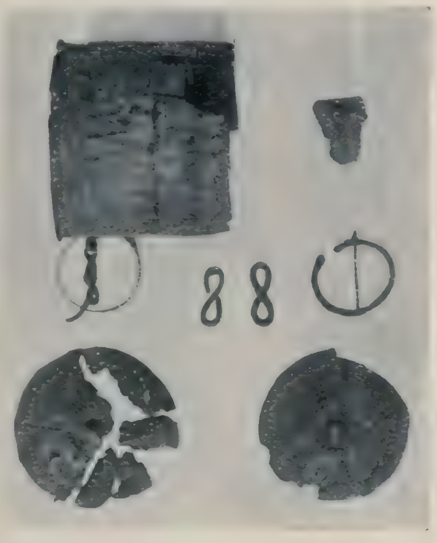


FIG. 2. SPECIMENS FROM THE LEEDS MUSEUM, WHICH WERE FOUND IN A TUMULUS, NEAR THIRSK.

These include fibulæ (or brooches), and a very beautifully worked bracelet, clasped with little chains.

his traces at the end of the last glacial age contemporary with the reindeer in France, very likely 70,000 years ago.

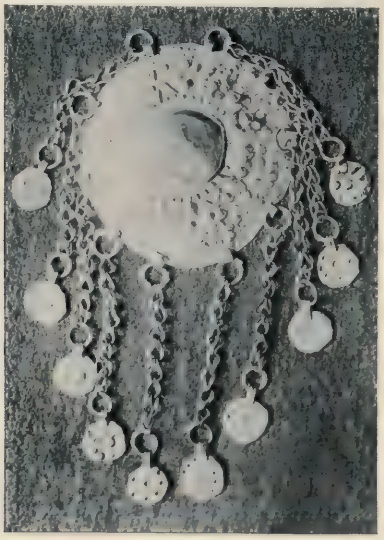


FIG. 3. SYRIAN HEAD-DRESS WITH SILVER CHAINS.*

It will be quite understood that this is not an attempt to fix a date in antiquity for this particular specimen of grass chain, but only to show the possible antiquity of its kind.

EARLY CHAINS IN GOLD SILVER, AND BRONZE.

Next in order of antiquity to fibre would come gold, because it is found in nuggets, and is very malleable in the cold state; also because it is so attractive in appearance. It is natural to find the earliest handicraft devoted to personal adornment, and within the last fifteen months at the ruined city of Abydos, in Upper Egypt, there has been a find of gold ornaments which, according to Professor Flinders Petrie, are probably 6,000 years old.

The illustrations next following show examples which are of silver and bronze, but there is no suggestion of such remote antiquity for these.

FIGURE 8 LINK, VARIETY OF FIRST TYPE.

The specimens shown in fig. 2 from the Leeds Museum, were found in a tumulus, at Sunnybank, Hornby, near Thirsk. They are of bronze, and a flint implement was found with them. There is a fibula, and a very beautifully worked bracelet, clasped with little chains. The chains are nicely formed of bronze wire bent into the figure 8, but not brazed at the ends. They are a variety of type No. I.

Fig. 3 shows a Syrian head-dress, with the silver chains and a piece of silver attached to the end of each chain. This is such a head-dress as was probably possessed by the woman in the parable, who, "having ten pieces of silver, lost one piece and searched diligently till she found it." This ancient chain is made exactly on the construction of type No. II. This type is well adapted for chains of gold or silver, and especially of gold, because it would be beaten out cold from native pieces of gold, beaten into a jointless ring, then bent and looped into a series of jointless rings, making a chain.

The construction of this chain is good, so much so, that ever since patents were established this form of chain has reappeared periodically in the Patent Office.

Fig. 4 shows a bronze chain of the same excellent type. The chains are attached to a large ring, and from one is depending the bronze stopper of a lamp. The rings have been elongated, bent nearly double, and looped together. It was found by Lord Saville at Lanuvium.

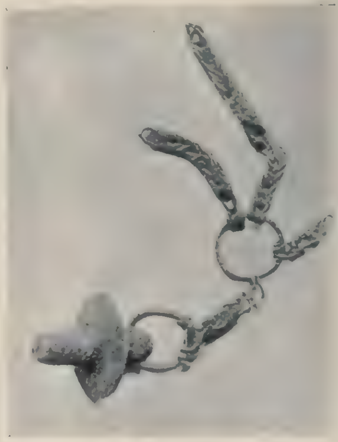


FIG. 4. A BRONZE CHAIN OF THE SAME TYPE AS FIG. 3.

The chains are attached to a large ring, and one of them bears the bronze stopper of a lamp.

---

* This Syrian head-dress is the property of Mr. Aquila Dodgson, who kindly lent it, and also the book and chain shown in fig. 12 to be photographed for this paper.

The old Latin cities, of which Lanuvium was one, existed before the foundation of Rome, and there is nothing to prevent this chain dating from 1000 B.C. This is an example of the value of metal chain where fire is near. Besides being more ornamental than cords of fibre or of skin, a metal chain is more serviceable, in that it resists accidental burning by the lamp. This chain 1000 B.C brings us within the epoch of metal chains other than gold.

ANCIENT TIBETIAN BRASS CHAINWORK.

A Tibetian ornament is shown in fig. 5, consisting of a brooch and chain with toothpick attached. The whole is of brass, a beautiful yellow alloy, with the exception of the iron pin of the brooch. From the imperfect way in which this pin is fixed, we may infer that it was a subsequent addition. It has worn away some of the ornamental face of the brooch, showing that it was actually worn for a long time by its possessor. The chain is made of little hoops of brass interlacing each other, after the type No. I., but these links are not solid, nor are they brazed at the joints, and they would have very little strength to resist opening. It is interesting to see in this ornament an *iron* pin preserved. The fewness of ancient iron relics may arise from the fact that iron, if exposed to damp, rapidly turns into rust, and being chiefly useful for outdoor work and not for ornament, is not often left in a position to be preserved for thousands of years.

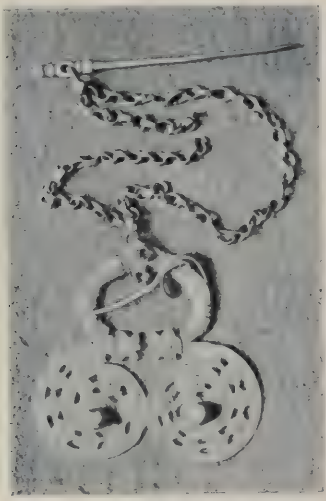


FIG. 5. TIBETIAN BROOCH AND TOOTH-PICK.
The whole is of brass, with the exception of the iron pin of the brooch.

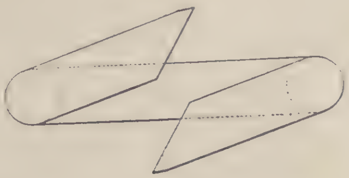


FIG. 6.

The chain-maker having a number of those partially formed at his fire, each link is in turn heated all over, passed through the last link and the scarfed ends are closed.

We have now seen chains for ornament and light use made of plaited grass, silver, and brass, but for heavy use iron is the material of which chains are almost exclusively made.

IRON CHAINS.

Iron differs from other metals in having a plastic weldable condition over a considerable range of temperature between the molten and the rigid state. In this plastic condition the links are easily formed by passing an open ring through a closed ring, and then closing the new link and welding the joint (figs. 6 and 7). Dr. Percy explains this notable characteristic of iron thus : " Iron has one remarkable and very important property—namely, that of continuing soft and more or less pasty through a considerable range of temperature below its melting point. It is sufficiently soft at a bright red heat to admit of being forged with facility, as every one knows, and at about a white heat it is so pasty that when two pieces at this temperature are pressed together, they unite intimately and firmly. This is what occurs

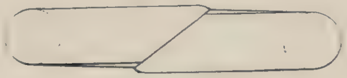


FIG. 7.

After being closed as shown in this figure the scarfed ends are locally heated and welded up.

in the common process of welding. Generally, metals seem to pass quickly from the solid to the liquid state, and so far from being pasty and cohesive at the temperature of incipient fusion, they are extremely brittle, and in some cases easily pulverisable. But, admitting that there is a particular temperature at which a metal becomes pasty, its range is so limited in the case of the common metals, that it would scarcely be possible to hit upon it with any certainty in practice, or if it were possible, its duration would be too short for the performance of the necessary manipulations in welding. Besides, there is another condition which might interfere with the process.

In order that union should take place between two contiguous surfaces of a metal, it is obviously essential that they should not be covered with any infusible matter, such as scale due to oxidation. In heating iron to the welding temperature, a scale is formed which may be immediately converted into very fusible and liquid silicate of protoxide by throwing a little sand over it, when welding may be effected, the silicate being squeezed out during the operation and clean metallic surfaces brought together. Every blacksmith resorts to this simple expedient of using sand as a flux, but in the case of some of the common metals it would not be very easy, or, indeed, practicable, to find a suitable flux, and to insure this condition."

But though iron has been known for 6,000 years, iron chains of importance are comparatively modern, and the oldest chain of any sort does not date further back than 3,000 years.

Until very recently hemp ropes have been used where strength alone is required, but iron chains have been early used in war, in order to resist fire and sword. War prisoners were bound in chains and fetters of iron, in order that teeth and nails might not sever their bonds. When the Romans invaded Britain they used mooring chains for their galleys, in order that they might not be cut, to set the galleys adrift.

Sir John Oldcastle was said to be hanged in chains; for the reason that hemp rope would be burnt by the fire, over which presumably he was hanged.

AN EARLY EXAMPLE OF IRON CHAIN.

The wall sculpture from the Nimrûd Gallery of the British Museum is depicted at the head of this article (fig. 8). It is one of a series illustrating the campaigns of Assur-nazir-pal 884 B.C. It is a marble slab, entitled Siege of a City. It shows a battering ram and a chain to destroy the action of the ram (fire-water, soldiers, winning ramparts—infantry, bows and shields). It was found by Layard in the N.W. Palace of Nimrûd. The chain is exactly like our type No. I., except that the section of the links is square, instead of being round. If this be an iron chain, it looks like a very early one; it is made with circular links, like the grass chain and other ornamental chains. But these circular links are not the best shape for strength. Probably before many such chains had been made the blacksmiths would find that the circular links drew out into oval ones, and later chains would naturally be made with links approximately oval to begin with.

On referring to other finds in the mound of Nimrûd Dr. Percy writes :—

"That the Assyrians were well acquainted with iron is clearly established by the explorations of Layard, who has enriched the collections of the British Museum with many objects of iron from Nineveh of the highest interest. Amongst these may be particularly specified tools employed for the most ordinary purposes, such as picks, hammers, knives, and saws. There is a saw similar in construction to that now used by carpenters for sawing large pieces of timber across. It consists of a blade 3 ft. 8 in. long and 4⅝ in. broad thoughout its entire length, except at one end, where it is narrowed, and was no doubt let into a handle of wood, the rivets being visible upon it. It was found in the North-west Palace of Nimrûd, and could not be in date later than 880 B.C. The fact of iron having been applied to common hammer heads for which bronze might have proved a tolerably good substitute, indicates that iron was certainly as cheap, if not cheaper, in those days than bronze, and the correctness of this inference is strikingly confirmed by many other objects from the same locality, consisting of cores of iron around which bronze has been cast."

We therefore see that in 880 B.C. the use of iron was in full swing; that it was cheaper at that period than bronze, and that owing to its peculiar welding qualities it was the best material for making strong chain. We may, therefore, conclude that this chain was of iron, and also that it was a very early chain of that material. The circular shape of the links was the most natural form to begin with, and the easiest to make, but that form would not long survive the test of practical experience.

IRON CHAINS USED BY THE ROMANS.

Besides the literary evidence of iron being used by the Romans, we are not without actual samples existing of iron chains made by the Romans, and we can see their form.

The Saalburg, near Homburg, was built and inhabited as a Roman fortress between the years II B.C. and 274 A.D., and there is still preserved the iron chain with its hook, which they used for elevating water from a well, also iron chains for horses. These iron chains are welded and are beautifully made, they are of type No. I. The well chain is of a flat rectangular section and oblong, something like the Roman chain which is depicted in a mosaic pavement excavated from Pompeii, and inscribed "Cave Canem." Pompeii was probably founded about 500 B.C., and was buried by lava in 79 A.D. The house was therefore built any time between these dates, and in the floor of the hall immediately behind the double front door was a dog attached to a chain, outlined in black and white mosaic, with the inscription, "Beware of the dog." These veritable examples of earlier iron chains are not of round section, but of rectangular section. This is accounted for by the fact that iron is more easily drawn down from a lump by hammering on an anvil into a flat or square rectangular section than into a round section. This is one reason why the Nimrûd chain may be considered to be iron. The sculpture does not show the links rounded, but flat.

Cæsar mentions that when he invaded Britain 55 B.C., the currency of the people consisted partly of iron rings adjusted to a certain weight. Thus, at the beginning of the Christian era, both the Romans and the Britons had long understood the working of iron. The Romans, as has already been said, used mooring chains for their galleys. They fortified York, and to join the walls across the river they were very likely to place a chain.

This brings us near home. The Romans were established in Britain more than 370 years, and during the space of three centuries and a half they had possessed the country of the Brigantes, of which the present county of York was the principal part. During this long space of time they had completely Romanised the country, and made the same improvements as in the rest of their provinces. The Romans did not leave much to chance, and, in addition to the walls and towers with which they made York impregnable, it is probable that they stretched chains across the Ouse to prevent an enemy's entrance within the city by water. At any rate, chains were used for that purpose later on, as Leland, who wrote at the time of Henry the Eighth mentions, in the following graphic account: "The Towne of York standith by west and est of Ouse river running through it. Thus goeth the waul from the ripe Ouse of the est part of the cite of York. Fyrst a grete towre with a chain of yron to cast over the Ouse, then another towre, and so on to Bowdamgate. From Bowdamgate or bar to Goodramgate or bar, X towres, thens four towres to Laythorp a postem-gate, and soe by a space of two flite shotts the blind and deep water of Fosse, cumming out of the forest of Galtres, defendeth this part of the cite without waulles, then to Waumgate three towres and thens to Fishergate, stopped up sins the Communes burned it yn the tyme of King Henry the Seventh.

Betwixt the beginning of the first parts of this west waulles and Micklegate, be IX towres, and at this XI towres be a postem-gate, and the towre of it is right agayn the est towre, to draw over the chain of Ouse betwixt them."

Of the probable form of the chain here spoken of we have curious indirect evidence.

Upon the Old Ousebridge there stood a chapel dedicated to Archbishop William Fitzherbert (twelfth century). At the Reformation, the chapel was converted into an Exchange for city merchants. Upon the decay of trade, it was divided into a Council Chamber, a Record Office, and a prison for the freemen of the city. The

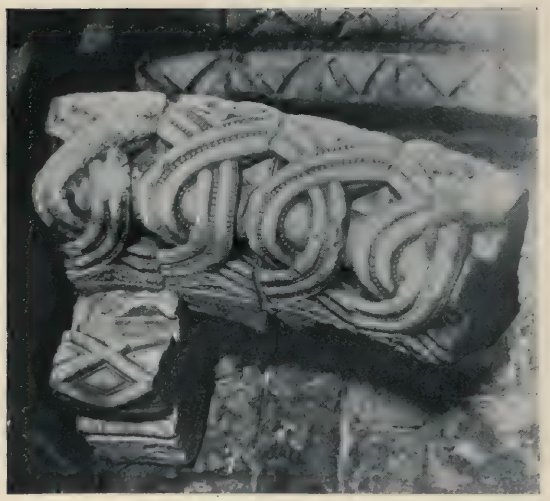


FIG. 9. PORTION OF AN OLD ARCH WITH CHAIN MOULDING PRESERVED IN THE HOSPITIUM AT YORK.

building was taken down in 1810. A portion of the arch in this chapel is preserved in the Hospitium at York. It shows a chain moulding which is a form of ornament found in Norman arches, and strongly suggests the existence of such a chain in the vicinity for the sculptor to have imitated. May it not possibly represent such a chain as even the Romans may have stretched across the river in the early centuries of the Christian era? The links are still of rectangular section, but are oval (fig. 9).

From such a chain as this twelfth century one (if it be not much earlier) at York we can find no improvement, till iron began to be rolled.

MEDIÆVAL BOOK CHAINS.

For examples of other mediæval chains we may turn to the chained libraries. For about three hundred years, *i.e.*, from 1395 A.D. to 1700 it was the fashion to chain books in churches and libraries. Many of these chained books are still preserved. The chains used are all either circular or somewhat long in the link, for it was not until 1812 that the perfected form of short oval link, and of links with studs, were made as shown on a subsequent drawing.

For most of the information and views in this section of the subject the writer is indebted to a volume entitled "The Care of Books," by John Willis Clark, M.A., published at the University Press, Cambridge.

Fig. 10 shows part of the bookcase in the Chapter Library at Hereford.

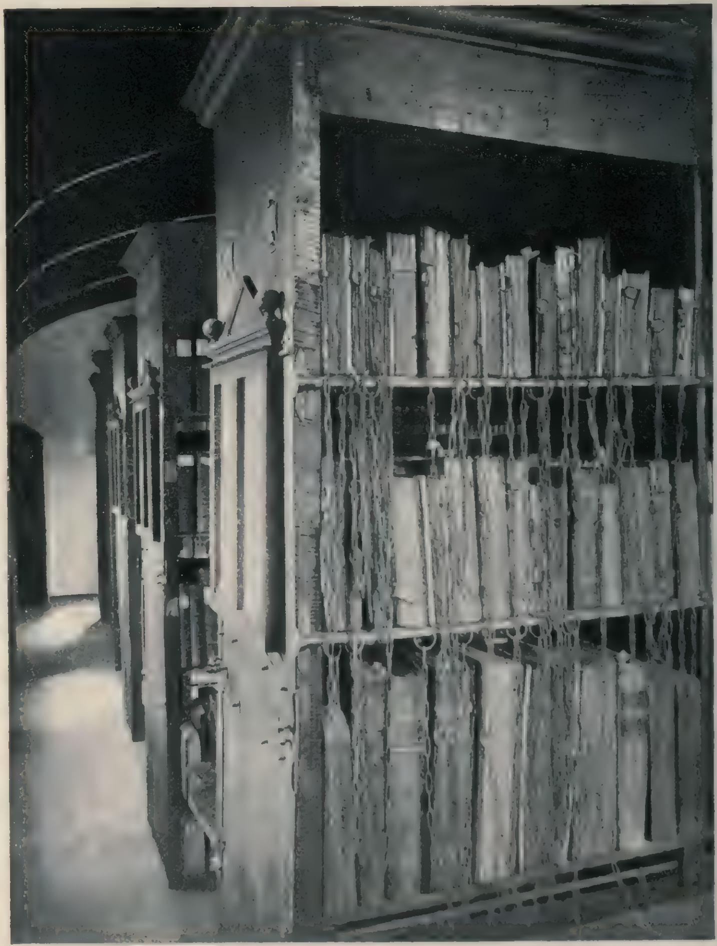


FIG. 10. PART OF THE BOOKCASE IN THE CHAPTER LIBRARY AT HEREFORD.

We will look a little more closely at some of these chains. Fig. 11 illustrates a piece of chain from Hereford showing the swivel, and it will be noticed that the links are forged of square section, they are long and oval.

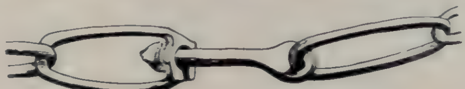


FIG. 11. BOOKCHAIN FROM HEREFORD.

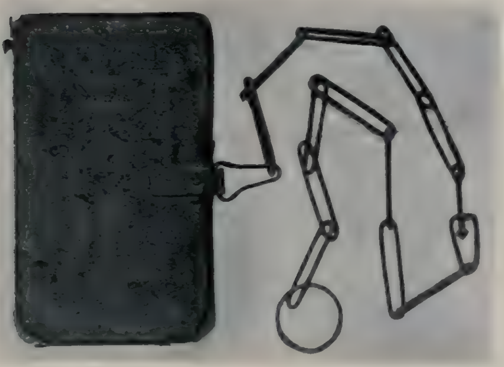


FIG. 12. A BOOK AND CHAIN BELONGING TO MR. AQUILLA DODGSON.

In the fifteenth century Cesena, a city of Northern Italy, between Forli and Ravenna, was governed by the powerful family of Malatesta, one of whom built the library in 1452. A part of a bookcase at Cesena is included to show the system of chaining (fig. 13).

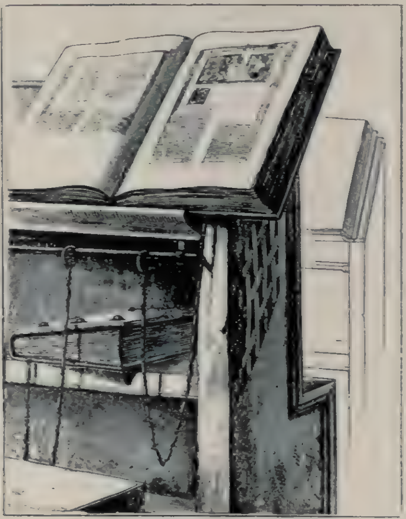


FIG. 13. A PART OF THE BOOKCASE AT CESENA, SHOWING SYSTEM OF CHAINING.

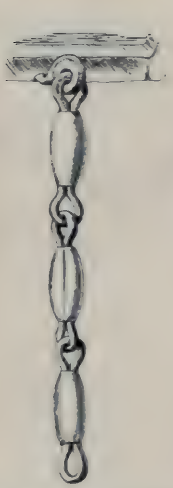


FIG. 14. A CLOSER VIEW OF THE CESENA CHAIN.

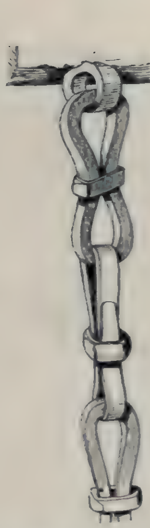


FIG. 15. TYPE OF CHAIN USED IN THE MEDICEAN LIBRARY, FLORENCE.

The chains are of unique form (see fig. 14). Each link, about 2¼ in. long, consists of a solid central portion, which looks as though it were cast round a bent wire, the ends of which project beyond the solid part. The chain is attached to the book by an iron hook screwed into the lower edge of the right-hand board near the back.

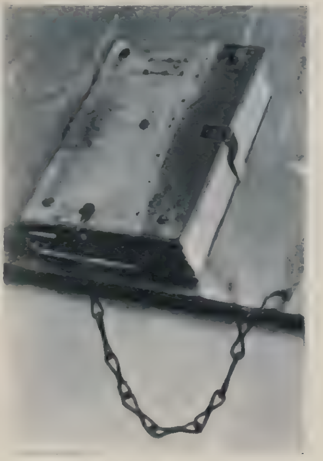


FIG 16. CHAINED BOOK AT GENT.

Michael Angelo built the Medicean Library in Florence for Pope Clement VII., which was finished in 1571. Fig. 15 shows the sort of chains that are there. They are made of fine iron bars about ⅛ of an inch wide, but not

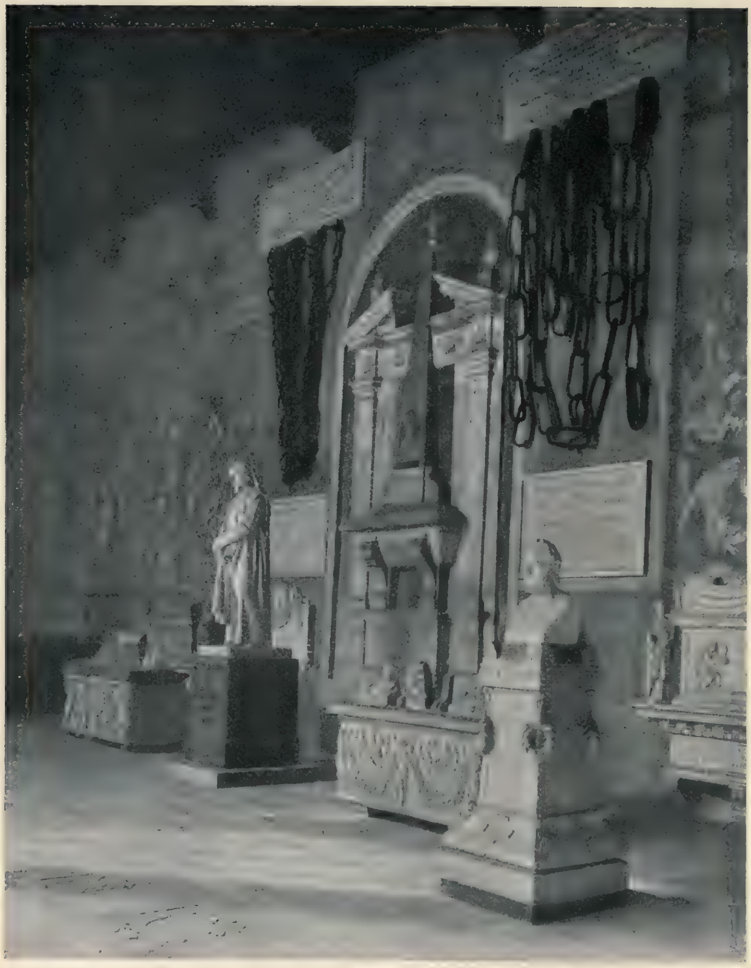


FIG. 17. HARBOUR CHAINS IN THE CLOISTER OF THE BURIAL GROUND AT PISA.

quite so thick, flattened at the end of each link and rounded in the centre, where a piece of the same iron is lapped round. Each chain is 2 ft. 3 in. long. There is a ring at the end of the chain next to the bar, but no swivel.

A volume printed in Bavaria in 1479 is shown with its chain at Gent (fig. 16). The chain is 24 in. long. The links of which there are ten, are compressed in the midddle, so that the two sides touch each other. There is no swivel, but a link rather larger than the rest, is passed round the bar.

It is recorded that Roger L'Isle, Dean of York, in the early part of the thirteenth century, bestowed several exemplars of the Holy Bible to be used by the scholars of Oxford under a pledge. These books were to be locked up in chests or chained upon desks in St. Mary's chancel and church. The practice of having books in chains was abandoned in the eighteenth century.

CHAINS FOR CAPTIVES.

In 1492 Ferdinand, King of Aragon, and Isabella, Queen of Castille, conquered Grenada and overthrew the Moors. They set free the Christian captives from the dungeons, who sent their chains as votive offerings to hang on the church at Toledo, which was built by Ferdinand and Isabella, and called the Church of the Kings, so called because both of the founders were sovereigns in their own right. The chains are chiefly placed within four panels with traceried heads. There are also two chains in the heads of each of the sixteen tall niches beneath the four panels before mentioned.

In the oldest chapel cloister of the burial ground of Pisa there hang upon the wall the chains of the ancient harbour of Pisa, captured by the Genoese in 1632 (fig. 17). They are very much like more modern mooring chains. The cathedral of Pisa was erected after the great naval victory of the Pisans near Palermo 1063, and it is possible that similar chains guarded their harbour at that time.

PORTCULLIS CHAINS.

The portcullis is always pictorially represented with two strong chains. The only place in England where the Portcullis remains is in the Tower of London, where the portcullises of the Bloody Tower and the Byward Tower are still preserved in working order. The apparatus for raising and lowering them, however, consists of a winch with pulley blocks and hempen ropes. The apparatus is in the tower above the portcullis. There are no ancient chains to be seen in the Tower of London.

CHAINS USED IN BUILDING CONSTRUCTION.

St. Paul's Cathedral, with its celebrated dome, higher outside than inside, was completed by Sir Christopher Wren about two hundred years ago, and he put an iron chain round the base of the cone (fig. 18). The construction of the wooden external dome, and the support of the stone lantern by an inner cone of brickwork, quite independent of either the external or the internal dome, are wonderful examples of Wren's constructive ingenuity.

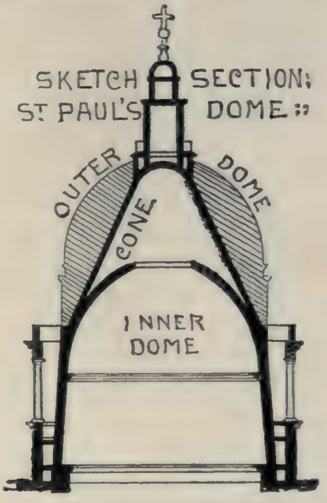


FIG. 18. ILLUSTRATING THE USE OF CHAIN IN DOME CONSTRUCTION.

In the "Parentalia," written by Wren's grandson Stephen, partly in his own words, partly in those of his grandfather, is this passage: "Although the dome wants not butment, yet for greater caution it is hooped with iron in this manner; a channel is cut in the bandage of Portland stone, in which is laid a double chain of iron strongly linked together at every 10 ft., and the whole channel filled up with lead." *

CHAIN CABLES.

It has been remarked before, when looking at the mediæval chain ornament at York, that we can find no essential improvement in the form of link, till within the last hundred years, but the old patterns overlap the new, and fig. 19 shows the chain cable of a Russian line of battleship sunk at Sevastopol by the Russians, after the battle of the Alma, and presented to the Leeds Museum by Mr. Henry Dixon. The links are remarkably similar to the Pisan harbour chain, only the section of iron in the older chain is rectangular, being forged out entirely by the hammer, whereas the section of the Russian chain is round, indicating the use of grooved rolls to prepare the round bars, of which the links were made.

Let us now revert to type No. II. We remember the Syrian silver chain made on type No. II. by looping one bent ring through another. In 1791 Colin Mackenzie patented a link to be connected by passing one through the eyes of the other, and in the year 1822 James Gladstone, of Liverpool, patented what he called "an invention of a chain of a new and improved construction." *See* "Traill's Chain Cables and Chains." It hardly has improvements enough over the silver chains in the Syrian head-dress to constitute an invention. It is true that the links are lightly welded together in the middle, and studs were fitted, as shown on the sketch, which is the direction in which this type No. II. has been developed We are now familiar with it in picture chains, bell pulls, etc. Such links are stamped out of brass or steel solid in the middle, and having two eyelets, which are bent together, and through which the next link is passed.

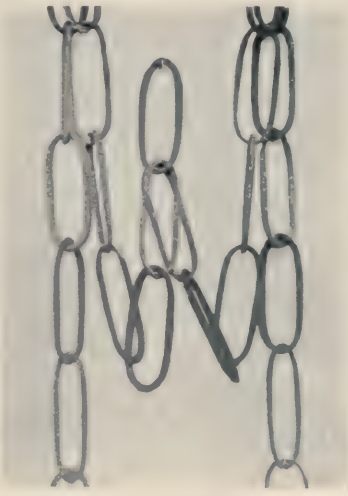


FIG. 19. THE CHAIN CABLE OF A RUSSIAN BATTLESHIP SUNK AT SEVASTOPOL

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* The author is indebted for the above information to Mr. Francis Bond, M.A.

About thirty years ago an attempt was made so to improve this type of chain as to make it suitable for ship's cables and rigging, and it was actually used in the French Navy. The name of the inventor was David, but the sample shown in fig. 20 was made by Brown, Bayley and Dixon, of Sheffield, and was lent for the purpose of this paper by Mr. Robert Armitage, of Farnley.

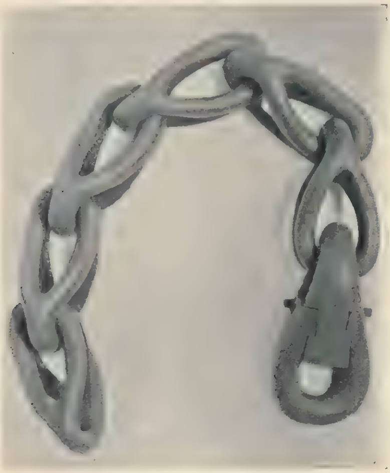


FIG. 20. TYPE OF CABLE CHAIN USED IN FRANCE.

Nothing better than this sample can be expected from type No. II., but for ships' cables and crane chains, the type is inferior to No. II., because it is not so good a form for winding round a capstan or the barrel of a crab. Also because the eyelets are split, they have their strength divided, and if an oblique strain comes upon the chain they can be broken one at a time. They also present a larger surface for oxidation. This form of chain is, however, largely used in France for coupling chains on railway trains.

19th CENTURY IMPROVEMENTS.

An admirable account of the history of chain cables is to be found in a book entitled "Chain Cables and Chains," by Thomas W. Traill, C.E.R.N., published by Crosby, Lockwood and Co., and the writer is indebted to that work for the sketches given at the beginning of this paper, and for the historical information which follows in this division of the subject,

It was in 1784 that Henry Cort invented the process of puddling iron and rolling it into rods with grooved rolls. These inventions opened the way for making chain cables with links of uniform section and quality. There had long been a craving for chain cables to take the place of hemp hawsers on ships. Sir Cloudesley Shovel recommended them in about the year 1700. and previously, viz., in 1634, a patent was obtained by an Englishman of the name of Phillip White, blacksmith, for "a way for the mearing of shipps with iron chaynes by finding out the true heating, p'paring and temp'ing of iron for that purpose; and that he hath now attayned to the true use of the said chaynes, and that the same will be for the great saveing of cordage and safety of shipps, and will redound to the good of our co'mon wealth."

No further mention of the use of chain, either as moorings or cables, is made until so far forward as the year 1804. By that time rolled bars of puddled iron were available, and a patent was enrolled by one John Slater, a surgeon of Huddersfield, in the county of York, "for a new and improved method of manufacturing and fabricating of cables, shrouds, stays, and other articles for the rigging of ships of materials never before used for that purpose." No result came of the invention, and the field was still left open for the practical and positive introduction of cables made of chain for the use of the naval and mercantile marine of the world.

This took place in 1808, when Robert Flinn, an Irish blacksmith, whose father fought under General Wolfe, who fell in the elder Flinn's arms, made iron chain cables at his forge in North Shields, which were used in a vessel called the *Ann and Isabella*, built at Berwick-on-Tweed; and in the same year Lieutenant Samuel Brown, of the Royal Navy, fitted out a vessel called the *Penelope* with her entire rigging of chain and with chain for her cables.

Up to this time chain was only known to be made by welding on the ends, and in 1811 many chain cables parted. This led to the introduction of testing machines for proving every part of the cable before it left the works for service. Experiments on the testing machine

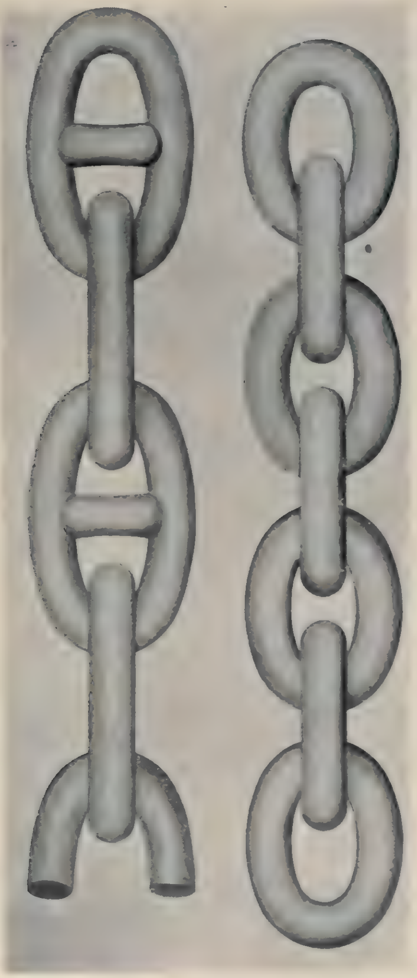


FIG. 21. MODERN CHAIN CABLE.

led to welding the links on the side when made of iron more than 1 in. in diameter, with a long scarf, which gave the men room and iron to work upon. Also it led to the adoption of the stud to keep the links from collapsing, and so to preserve the freedom of the joints, and consequently the cable's flexibility.

MODERN CHAIN CABLE.

In 1816, Brown's second patent, the veritable chain cable of the present, was first made. Previous to that date studs were unknown, and above all short links of only 4½ diams. or even 5 diams. of the iron were unknown. The form of this chain, as shown in fig. 21, is well nigh perfect. It is elliptical, which gives a curve of the same radius as the iron of which the links are made at the inside ends of the links, so that the links bed on each other with surfaces which coincide, while the enlarging radius of the ellipse allows clearance sideways to give flexibility to the chain. The weld is about ·8 of the strength of the bar, and the breaking strength of the chain is about 1·5 of the strength of the bar. But before the breaking strength of an unstudded chain is reached the links become deformed and locked, and the flexibility of the chain is gone. It may, therefore, be fairly argued that the weld does not take away from the useful strength of a chain, but its disadvantage is that it necessitates the chain being made of iron, soft enough to be capable of welding. If, therefore, it be possible to make chain with interlaced links without welding, then very strong hard steel could be used, and the chain of the future could be made of double the strength, weight for weight, of the present-day chain. At first glance it might seem difficult to form interlaced links out of a solid bar, but many a collier in his leisure hours has performed the feat of cutting a wooden chain out of a besom-tail.

But if it be possible to form a wooden chain with solid links it is also possible to form it of hard steel.

Fig. 22 is from a beautiful photograph made for this article by Mr. Crowther, who himself

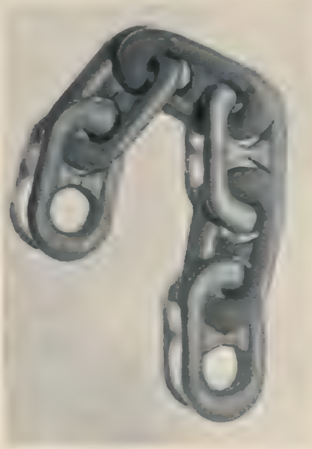


FIG. 22. A CHAIN IN POSSIBILITY.
Two hundred yards of this chain are in work at the West Riding Colliery, Normanton.

obtained the specimen from which the photograph was made. Although it represents an actual chain, it could not be made to-day for a guinea an ounce. It represents a chain in possibility. Two hundred yards of this chain are in work at the West Riding Colliery, Normanton, and the specimen has been presented to the Leeds Museum by Mr. W. E. Garforth. It is the best piece of chain which they have on the colliery, but no more is forthcoming made as this was.

It will be noticed that there are studs, and the ends of the links are made with a deeper section than the sides, so as to allow for wear. Add to this that it is made of steel. It is an ideal chain, and has twice the strength and twice the wear of a chain made from welded iron rods.

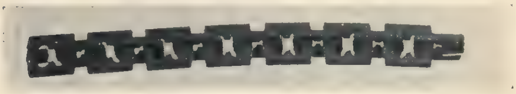


FIG. 23. FIRST STAGE OF THE SAME CHAIN.

Fig. 23 shows the first stage of the process by which it was made. The openings in the links were punched out cold from a bar of cruciform section. The process is too expensive and too wasteful of material to be continued, but it is an ideal chain. Renewed efforts are now being made to produce this ideal chain with commercial success.

Fig. 24 illustrates a method of rolling it hot till it is nearly formed, and shows it at a further stage when the thin films remaining from the rolling have been punched out, but along the centre of the chain bar there still runs a solid rod, which has to be cut out with shaping tools to separate the links; after this the links are heated and squeezed oval.

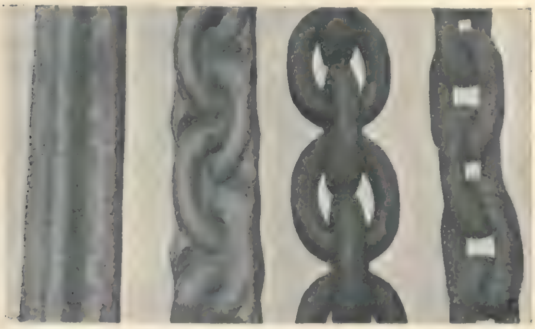


FIG. 24. DEVELOPMENT OF CHAIN FROM THE BAR.

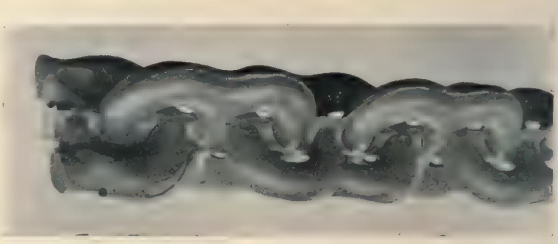
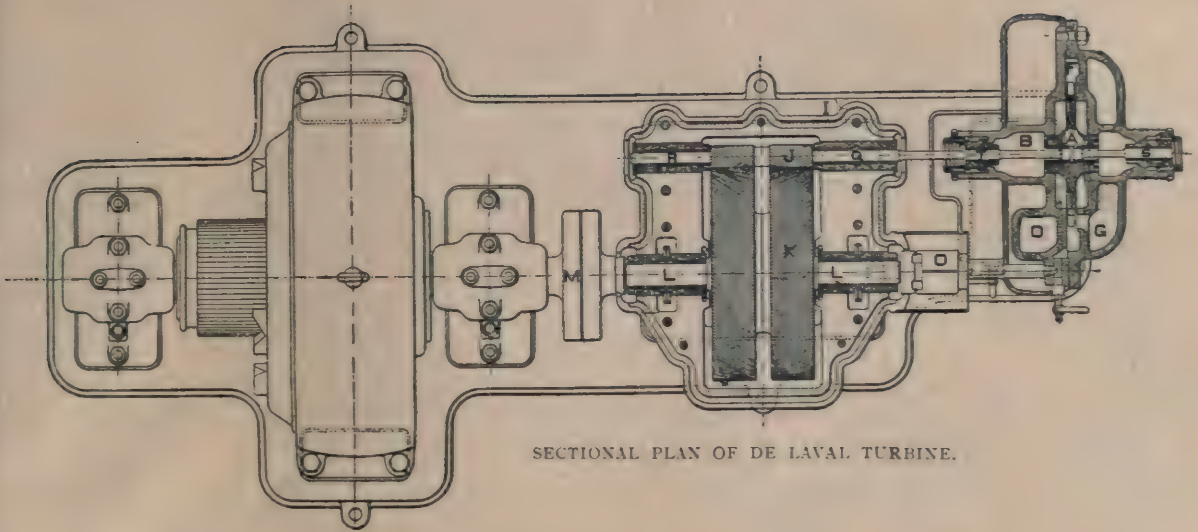


FIG. 25. A CHAIN BAR BEFORE THE ROD IS CUT OUT.

Fig. 25 presents a view of a rolled weldless chain bar after the thin films have been punched out, and before the solid rod running along the centre has been cut out and the links separated, and bent into their finished oval form. This is the chain in possibility.

If a weldless chain of strong steel comes into use in the near future it will bring about a sudden improvement of 2 to 1 upon the chain that has prevailed for a hundred years—that is to say, it will double the strength, weight for weight. Its development arises from an improvement in mechanical art concurrently with the improved production of steel. The chain of the present suddenly doubled the efficiency of all previous chains. It was brought into being owing to the demand for chain cables for ships, together with the improvements in working iron invented by Henry Cort. Before that there was no substantial improvement in chain-making for nearly three thousand years. Previously to 1,000 B.C. we cannot trace the existence of iron chains at all, yet iron itself must have been known and used in Egypt six thousand years ago. It seems, therefore, to have taken three thousand years with the knowledge of iron to make a beginning with iron chains, then there was little or no improvement for a period of three thousand years, when suddenly the beautiful round section oval-shaped short link chain of Robert Flynn, and the stud link chain of Lieutenant Brown in 1812, made a 2 to 1 improvement on the previous square cornered self-destructive chain, and then, after a period of only a hundred years, we foresee another 2 to 1 improvement. The acceleration of improvement may come to us thirty times as swiftly for the last improvement as it did for the previous one.



SECTIONAL PLAN OF DE LAVAL TURBINE.

THE STEAM TURBINE.

BY

HOMER M. JAQUAYS.

Mr. George Westinghouse on a recent occasion said : " The steam turbine is not a new and comparatively untried invention, as many laymen seem to think. There are half a million horse-power of Parsons Steam Turbines in daily operation in different parts of the world ; eighty-four thousand horse-power of these are in steam vessels. In the United States alone there are 60,000 horse-power of a stationary type used in connection with electric light and power in continual **operation, and 150,000 horse-power more are already contracted for and are now under** construction at Pittsburg, where units as large as 8,000 horse-power are being built. The impression in the public mind that the steam turbine is a new thing, is probably due to the fact that attention is frequently called to new makes of turbines. The fact is, these new types have not demonstrated any superiority over the Parsons, which is the only turbine of world-wide repute and operation, and is the only one which will give, or is at present capable of giving, highly economical results. Other turbines have made claims to economy, but they justify these claims only when they **borrow the Parsons idea, which is fundamental. I have made a broad investigation of this** question, with the result that the Parsons turbine is the one with which I have concluded to ally my interests. We shall build up a great marine turbine industry in the United States. The importance of the marine turbine has not been overestimated, and it is long past the stage of experiment. We need not call the turbine the engine of the future, it is decidedly the engine of the present."—ED.

IT is interesting at times, in the course of the development of an art, which is progressing in various places and by divers means, to collect as much information as possible concerning it, so that existing conditions may be compared with the past and some insight gained into the possibilities of the future. This fact, perhaps, justifies an attempt to contribute something concerning the steam turbine, even at a time when so much is being published in the current magazines and in the records of engineering societies. The matter in most of these articles is, however, largely made up of reports of single tests or series of tests on one machine and particulars of special turbines ; while the object of this paper is simply to put their information in such a form that the comparisons referred to above may be easily made.

The turbine, the oldest type of steam engine, has always attracted more than an ordinary amount of attention, but the results of the epoch-making events of 1884 and 1889, when patents were awarded the Hon. Chas. Algernon Parsons and Dr. Gustaf De Laval respectively, have increased this interest to an almost unlimited degree. Trevithick, Pilbrow, Wilson, and possibly others, grasped the salient features of the modern turbine ; but it needed modern workshop facilities, with the attendant accuracy of workmanship and attention to detail, to make the turbine a commercial success. And when we realise that it is not twenty years since the application was made for the first letters patent for the Parsons turbine, and that it was as late as 1891 that the first condensing turbine was produced, we cannot but wonder at the success it has achieved and the world-wide interest it has excited. Previous to the last decade, conservative engineers in general undoubtedly looked askance at rotary engines and turbines ; but it needs only a glance at the modern turbine to perceive mechanical features which must meet with approbation, while a closer examination cannot fail to call forth admiration for the ingenuity displayed and the persevering attention to detail shown in every part.

TURBINE TYPES COMPARED.

The modern parallel flow turbine is too well known to need a detailed description, but it will not be amiss to insert here the general principles of its chief types. They all depend for their action upon the conversion of the kinetic energy, caused by the expansion of the steam into work done on the rotating turbine shaft. In the De Laval turbine the expansion of the steam takes place in one or more nozzles before it reaches the turbine blades. In the Parsons this expansion takes place during the passage of the steam through the turbine, while in the Curtis turbine we have the application of both these principles. The De Laval, with its one row of blades, must, in order that the velocity of the steam leaving the blades be not excessive, have a very high peripheral velocity. In the Parsons and Curtis turbines, however, the employment of many rows of stationary and rotating vanes makes it possible to diminish the speed of the turbine shaft without reducing the efficiency.

As regards the velocity of the turbine blades, it is not difficult to find the one that is most efficient. Suppose V_1 be the absolute velocity in feet per second of the steam as it strikes the vanes, and V_2 the absolute velocity of the steam leaving the vanes, the greatest amount of energy that can be given to the turbine per pound of steam is $\frac{V_1^2 - V_2^2}{2g}$ foot pounds, and in order that this should be a maximum, V_2 must equal nothing. This is the case when the velocity of the vane is one-half the velocity of the impinging jet, and when the direction of the motion of the vane is parallel to that of the impinging and leaving jets.

This condition cannot be realised in steam turbines, though it may be noticed in passing that a close approximation to it is obtained in the case of the Pelton water wheel. But the velocities dealt with when working with steam are immensely greater than can ever be experienced with water. Thus, with a head of 200 ft., the velocity of the water entering the turbine could not exceed 113 ft. per second. In the case of turbines of the De Laval type, however, where the steam expands in a diverging nozzle from initial pressure to condenser pressure, it is estimated that velocities of 4,000 ft. or more per second must be employed. This velocity can, of course, be regulated by the form of nozzle. But for economical working, as large a proportion as possible of the heat energy of the steam must be changed into the kinetic energy of the gas, the velocity of which, since it has a large specific volume, must be very high. It is stated above that for maximum efficiency the velocity of the vane should be one-half the velocity of the impinging jet. But a vane velocity of 2,000 ft. per second would, of course, cause such centrifugal forces in the turbine wheel as no known material could safely bear. Turbines, with a single row of vanes using high pressure steam, must consequently run at a speed lower than the most efficient—a peripheral velocity

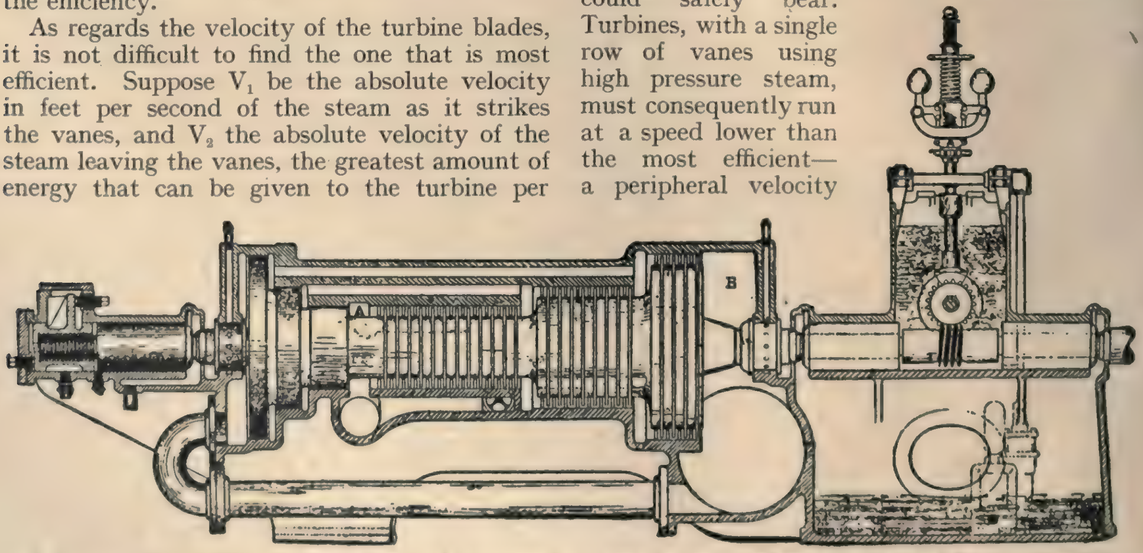


FIG. 2. LONGITUDINAL SECTION OF THE PARSONS TURBINE, AS MANUFACTURED BY THE WESTINGHOUSE MACHINE COMPANY.

The Westinghouse Parsons Turbine is manufactured in this country by the British Westinghouse Company.

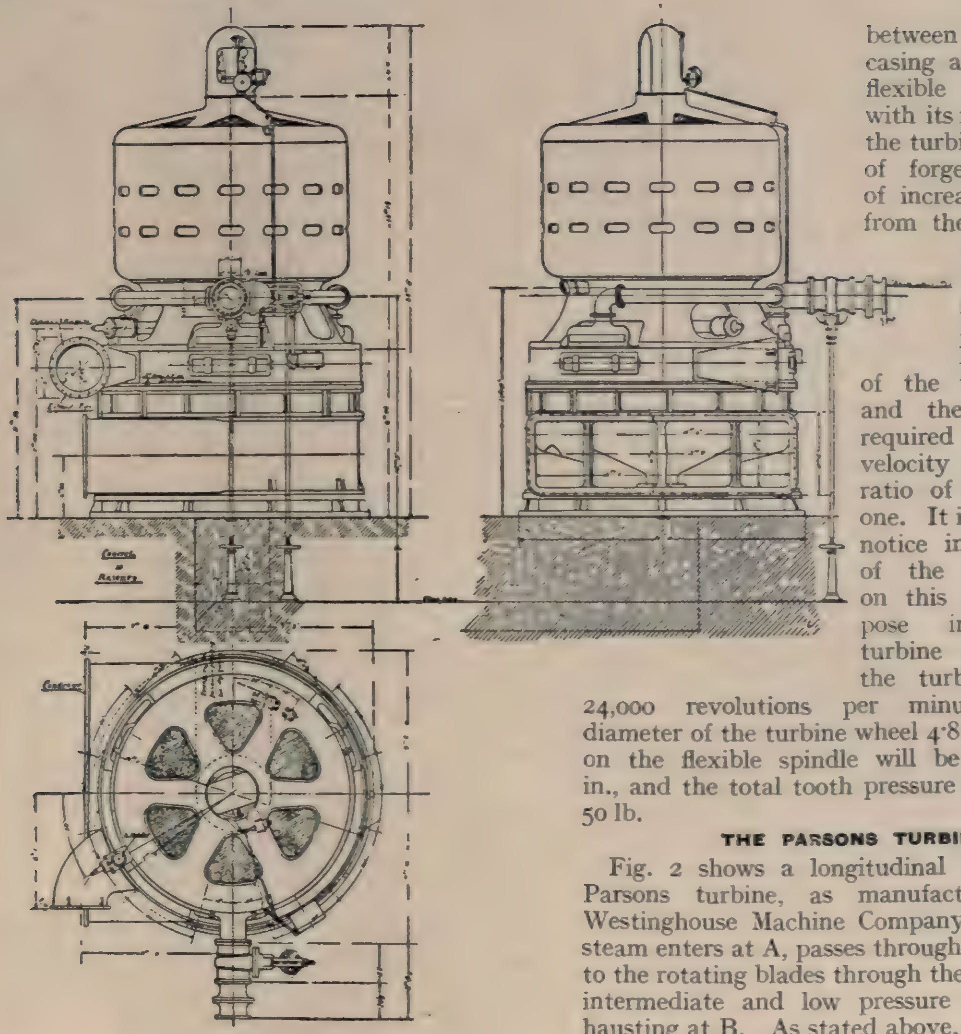


FIG. 3. THE CURTIS TURBINE.

of 1,000 ft. per second being about the limit. The introduction of many rows of moving and stationary vanes at once overcomes this difficulty. The steam loses some of its velocity at each row, and so, on this principle, turbines have been made that run efficiently at speeds not much in excess of those of some high-speed reciprocating engines.

THE DE LAVAL TURBINE.

Fig. 1 shows sectional plan of a De Laval turbine. The steam enters the nozzle from the chamber D, where it is completely expanded, passes through the turbine bucket F to the exhaust chamber G. The important features are the diverging nozzle referred to above, the fact that there may be considerable clearance between the wheel, casing and nozzle, the flexible turbine shaft with its flexible bearing, the turbine wheel, made of forged nickel steel of increasing thickness from the periphery to the centre to resist centrifugal force; above all the high velocity of the turbine wheel, and the gear wheels required to reduce this velocity usually in the ratio of about ten to one. It is interesting to notice in passing some of the forces acting on this turbine. Suppose in a 10-h.p. turbine the speed of the turbine shaft is 24,000 revolutions per minute and the diameter of the turbine wheel 4·8 in., the torque on the flexible spindle will be about 26 lbs. in., and the total tooth pressure approximately 50 lb.

THE PARSONS TURBINE.

Fig. 2 shows a longitudinal section of the Parsons turbine, as manufactured by the Westinghouse Machine Company. In this the steam enters at A, passes through the stationary to the rotating blades through the high pressure, intermediate and low pressure cylinders, exhausting at B. As stated above, because of the many rows of stationary and rotating vanes and the reduction of speed with each pair of vanes, the speed of the Parsons turbine can, by multiplying the vanes, be reduced to almost any amount. The end thrust is counterbalanced by three rotating pistons placed on the turbine shaft. Many of the details of the Parsons turbine are worthy of special study. The method of preventing leak past the balancing piston and the manner of getting the turbine shaft through the case are examples.

THE CURTIS TURBINE.

The Curtis turbine, unlike the two types described, has a vertical shaft in sizes above 500 kilowatts. It is perhaps best described in the maker's own words :—

> Each stage or element of the Curtis turbine essentially consists of a group of expanding nozzle sections, which delivers steam to the first of a group of wheels or

TABLE 1.—Trials of a 24 K. W. Parsons Turbo-Alternator

Number of Test	R. P. M	Pressure at Stop Valve, lbs. per sq. in. Gauge.	Vacuum in Turbine Cylinder Inches of Mercury.	Electric Output K. W.	CONSUMPTION OF STEAM.		Superheat °F.	REMARKS.
					lbs. per hour	lbs. per K. W. per hour.		
1	4990	80	28.8	24.7	712	28.8		Barometer = 30″.
2	4630	77	29 0	11.8	400	33.9		
3	4570	74	29.1	5.15	235	45.6		
4	4900	78	26.0	23.8	798	33.5		
5	4780	79	0	19.7	1350	68 5		

TABLE 2.—Trials of a 50 K. W. Parsons Turbo-Alternator for the Blackpool Corporation.

1	5044	126	28.0	52 7	1480	28.0		Barometer = 30″
2	4880	132	28.5	—	320	—		

TABLE 3.—Trials of two 100 K. W. Parsons Turbo-Dynamos (d. c.) for West Bromwich.

1	3500	129	27.8	123	3144	25.5	54	Barometer = 30″.
2	3520	134	27 7	122	2913	23.8	64	

rings of buckets. Between the successive rings of buckets rows of stationary buckets, called "intermediates," are placed in the region opposite to the group of nozzles, the function of these intermediates being to reverse the motion of the steam received from one set of moving buckets, and to deliver it against the following set of moving buckets in an effective direction.

The steam from one group of nozzles may thus be passed by the action of successive intermediates through several rows of moving buckets, the number of such rows associated with a single group of nozzles being governed by various mechanical and theoretical conditions. The group of nozzles imparts motion to a column of steam, most of the energy of the steam expansion being transformed into this motion. This motion is then fractionally abstracted by the passage of the steam through the successive rows of moving buckets.

TABLE 4.—Trials of a 500 K.W. Parsons Turbo-Alternator at the Works of the Cambridge Electric Supply Company in January, 1901. Turbine in operation one year. Trials conducted by Prof. Ewing.

Number of Test.	R. P. M.	Pressure at Stop Valve, lbs. per sq. in. Gauge.	Vacuum in Turbine Cylinder. Inches of Mercury.	Electric Output. K. W.	CONSUMPTION OF STEAM.		Superheat. °F.	REMARKS.
					Lbs. per Hour.	Lbs. per K. W. per Hour.		
1	2670	148	25.7	518.0	12,970	25.0		Trials 1 to 5 Barometer 29.93″. " A and B " 29.99″ Turbine driving its own air and circulating pump. In test by makers, when new, machine showed load 526.4 K.W. Consumption, 24.1 lbs. steam per K. W. hour. Conditions of steam pressure and vacuum about same as in tests at Cambridge.
2	2741	145	25.4	586.0	14,320	24.4		
3	2630	151	27.2	273.5	7,730	28.3		
4	2590	151	27.8	160.5	5,320	33.1		
5	2580	121	28.1	0	1,850	—		
A	2880	145	25.1	535.0	13,350	25.0		
B	2800	150	26.2	300.0	8,270	27.6		

TABLE 5.—Trials of a 1000 K.W. Parsons Turbo-Alternator, for Elberfeld Corporation, at the makers' works, in January 1900. Trials conducted by W. H. Lindley, Prof. Schröter, and Prof. Weber.

II.		129	28.2	1190.1	23,067	19.43	18.4	For full particulars of these exhaustive trials see Revue de Mécanique, November, 1900.
I.		134	28.5	994.8	20,024	20.15	20.0	
III.		139	28.4	745.3	165,924	22.31	14.4	
IV.		132	28.5	498.7	126,180	25.20	52.5	
V.		129	28.5	246.5	83,028	33.76	30.6	
VI.		132	28.7	0	40,568	—	24.0	No load alternator excited.
VII.		134	29.0	0	26,026	—	24.3	No load without excitation.

The above-described circle of operations takes place in what is known as one stage of the Curtis steam turbine, and it is generally desirable to use two or more of such stages, in order that the expansive force of steam may be effectually utilised. Where a plurality of stages is used, the turbine conditions are so arranged that all the stages, under normal conditions, will perform approximately equal amounts of work. All the losses and efficiencies of one stage take the form of heat in the steam, and are therefore more or less available as motive force in the succeeding stages.

In our first commercial machines we adopted two such stages, three or four rows of moving buckets being used in each stage. In some of our later machines we have adopted four stages, with two rows of moving buckets in each stage. Under certain other conditions, other numbers of stages and arrangements of buckets will doubtless be adopted.

Parsons turbines have been running in England for over twelve years, a sufficient length of time to permit of some idea being formed as to their durability.

At Newcastle, a Parsons machine ran for thirty-six thousand hours without interrupted service, and at the end of the run there was no perceptible wear on the blades. The oldest Westinghouse-Parsons machine has been running for four years only. The repairs, however, during this time are said to have been light and of a minor character, with no perceptible wear on the blades.

TURBINE PLANTS IN OPERATION.

At the present time there are in England from six hundred to eight hundred turbine plants, either actually installed or sold. These aggregate 200,000 h.p. The largest unit installed is 3,500 h.p. A special feature might be noted here in this connection, that many of the plants in which the first installations were made have added further turbine horse power. On the Continent, Messrs. Brown, Boveri and Co., of Baden, Switzerland, manufacture the Parsons turbine. At the end of 1902 they had sold twenty plants, aggregating 29,000 h.p., the largest unit being 3,000 h.p. On this side of the Atlantic, the Westinghouse Machine Company, of Pittsburg, have made and have in service turbines to the amount of 6,500 kilowatts, while upwards of 5,000 kilowatts more have been shipped. The total turbine power already installed and in process of erection amounts to 110,000 kilowatts. Fifty-seven units will be in operation before the end of the next nine months.

There are unfortunately no figures at hand giving the total horse power of the De Laval turbines installed later than the year 1896, when it was said to be 23,000. Since that time some 13,000 h.p. has been installed in the United States alone.

Recent large contracts for and installation of Parsons and Westinghouse-Parsons turbines include among others the following :—

	Units.	Kilowatts each.
For the Philadelphia Rapid Transit Company, Philadelphia, Pa... ..	3	5,000
De Beers Consolidated Mines, Kimberley, South Africa	2	1,000
Metropolitan District Railway, London (England)	8	5,000
Metropolitan Railway Company, London (England)..	3	3,500
Cleveland, Elyria, and Western Railway, Cleveland, Ohio..	2	1,000
West Penn. Railway and Lighting Company, Pittsburg, Pa.	3	1,000
Rapid Transit Subway Construction Company, New York, N.Y.	3	1,250
Penn. R.R. Long Island Power House..	3	3,500

For the Metropolitan Railway Company's plant, the turbines are constructed by the Parsons Steam Turbine Company, and are guaranteed to have a combined efficiency of 17 lb. of steam per kilowatt hour, delivered at full load, and 20¼ lb. of steam for each kilowatt hour, delivered at half load, the boiler pressure being 160 lb. per square inch, with the steam superheated 180°F., 90 per cent. vacuum in the condenser.

Recent large contracts for and installations of Curtis turbines include :—

	Units.	Kilowatts each.
Commonwealth Station, Chicago ..	1	5,000
Lane Cotton Mills, New Orleans ..	3	500
Fulton Bag and Cotton Mills, Atlanta, Ga.	2	500

In all, 200,000 h.p. of Curtis turbines are said to be under contract.

These figures show that the turbine must now be seriously considered a rival of the reciprocating engine. For, while it is true that in America it is used almost entirely for driving electric machinery, yet in England it has already been employed as a blowing machine (the air compressor being a counterpart of the turbine) for driving centrifugal pumps with high lifts, for ventilating purposes, and for marine work. In these various positions its steady growth is the best indication of its performance; and it need not be restricted to these alone, for it is excellently adapted to other services, where its high speed is not a positive disadvantage.

STEAM TURBINE *v* RECIPROCATING ENGINE.

Comparing the steam turbine with the reciprocating engine, it is seen that the former has the following points of advantage :—The turbine has no valve gear, no vibration, is very light, and requires only sufficient foundation to bear its weight. It is the more simple of the

Table 6.—Trials of a 1,000 K. W. Parsons Turbine driving dynamos for Newcastle & District Electric Lighting Company's Power Station. Trials made by Mr. Hunter, Engineer to Newcastle & District Lighting Company

No. of Test.	R. P. M.	Press at Stop Valve lbs. per sq. in Gauge	Vacuum in Turbine Cylinder. Inches of mercury.	Electric Output, K. W.	Consumption of Steam.		Superheat °F.	
					lbs., per hr.	lbs. per K. W. per hr.		
1	1690	138	26	1011.6	21,734	21.48	71	Barometer = 30″
2	1680	140	26	909.0	18,610	20.47	86	
3	1700	142	26.2	894.6	17,760	19.85	128	
4	1660	144	26.3	890.7	17,020	19.1	132	
5		144	26.3	882.9	17,171	19.43	135	
6	1700	145	26.3	874.0	16,983	19.42	137	
7		145	26.3	901.1	17,500	19.29	137	
8	1680	146	26.3	896.7	17,302	19.11	136	
9	1640	142	26.4	862.2	16,479	19.15	136	
10		142	26.6	787.2	16,800	18.96	133	
11	1640	146	26.3	944.2	17, 03	18.78	131	
12	1660	140	26.3	986.6	18,434	18.52	142	
13	1710	135	26.3	942.5	17,559	18.52	146	
14	1710	135	26.4	942.6	17,460	18.52	182	
15		140	26.5	878.1	15,857	18.06	195	
16	1710	146	26.6	863.3	15,493	17.94	221	
17		145	26.5	897.8	15,922	17.73	237	

two. The torque on the shaft is uniform, and there are no moving parts to be brought to rest and accelerated twice in every revolution. Condensation should be small, and full advantage is taken of low exhaust pressures. With three-cylinder reciprocating engines, on the other hand, about the same results are obtained, with a seventy per cent., eighty per cent. and ninety per cent. vacuum. The turbine is compact. It is impossible to give figures of general application, but it has been calculated that it requires about eighty per cent. of the floor space of the vertical engine of the same power and one-half the engine-room capacity; about forty per cent. of the floor space required by a horizontal engine and a correspondingly smaller amount of engine-room capacity. It is a comparatively simple matter to erect and test at the maker's plant. It is admirably suited for the use of superheated steam. The

Table 7.—Trials of a 10 H. P. De Laval Turbine. Trials conducted by Prof. Goss.

Number of Test.	R. P. M.	Press. at Stop Valve. lbs per sq. in. Gauge.	Vacuum in Condenser. Inches of mercury.	B. H. P.	Consumption of Steam.		Superheat. °F.	REMARKS.
					lbs. per hour.	lbs. per B. H. P. per hour.		
1	2138	130	Exhaust at Atm. Press.	0.00	120.8	....	None	Trials 1 to 10 were made with four nozzles in operation.
2	2545	130		1.63	210.3	128.6		
3	2038	130		2.36	230.8	99.8		
4	2118	130		2.97	254.6	85.7		
5	1917	130		3.46	275.5	79.6		
6	2072	130		4.38	313.0	71.5		
7	2128	130		5.10	328.5	64.4		
8	2576	130		7.52	463.0	53.6		
9	2453	130		8.24	422.8	51.3		
10	2411	130		10.33	491.8	47.8		
11	2584	130		0.00	121.4	....		Trials 11 to 14 were made with three nozzles in operation.
12	2112	130		3.95	267.8	67 8		
13	2125	130		4.77	286.0	60.0		
14	2490	130		6.50	346.3	53.3		
15	2546	130		0.00	99.3	... .		Trials 15 to 18 were made with two nozzles in operation.
16	2049	130		1.95	162.6	83 4		
17	1909	130		3 43	222.9	65.0		
18	2412	130		3.87	229.6	59.3		

steam consumption is about the same as that of the reciprocating engine when new, but since there are no rubbing parts, the wearing of which causes leakage, this consumption should be approximately constant throughout the life of the turbine. Its consumption varies less than that of the reciprocating engine over wide ranges of loading. No cylinder lubrication is required by the turbine, in consequence of which the exhaust is pure, a matter of considerable importance where water is dear, while difficulties that are unavoidable in extracting the oil are not encountered. Incidentally because of this, less work is required in the boiler room.

The turbine is, because of the uniformity of its driving force, specially suitable as a prime mover for such a system as alternators running in parallel. With it there is no tendency to produce those periodic fluctuations of speed which occur during every revolution of a reciprocating engine. The problem of speed regulation is consequently much simplified. To effect this, it is only necessary to supply a governor, which will keep down fluctuations of speed due to a sudden change of load, prevent surging, and give the drop in speed from no load to full load that is necessary for parallel operation.

It is worthy of notice that all Westinghouse-Parsons turbines installed are running alternators in parallel, and their operation in this connection is guaranteed to be satisfactory.

Looking at the disadvantages, it must be noticed that, with some types of turbines, it is difficult to get the shaft through the case. All, for reasons referred to above, must have excessive speeds that do not permit of belt drives. Where many rows of vanes are used, the clearances must be small, causing expense because of the accurate workmanship required. In the De Laval type, however, the clearances may be very considerable—are, in fact, from two to five millimeters.

COST AND ECONOMY OF TURBINES.

It would be surprising if, for a time, the initial cost of turbines were much below that of reciprocating engines. The experimental work of years undertaken by the producers has undoubtedly involved great expenditure, and it is only right that they should receive remuneration in proportion to the incurred expense and to the risk involved. Speaking generally, the first cost of a turbine and its alternator will not differ much from that of a cross compound Corliss engine with its alternator of good manufacture. When, however, the cost of foundations, engine-room capacity, and floor space is taken into account, any advantage in price is probably with the turbine. The cost of attendance, repairs, oil, etc., should be less in the case of a turbine than of a reciprocating engine.

As regards economy, it will be seen from the accompanying tables of results of trials that the consumption is not much different from that of the best reciprocating engines when running at most efficient loads. At light loads the turbine ought, from its construction, to have an advantage over the reciprocating engine.

EFFECT OF SUPERHEATING.

The turbine is admirably adapted to the use of superheated steam, the smaller fluid friction, due to the use of a rarer gas and the elimination of water, having a marked influence on the economy. Just how great a reduction in the consumption superheating will ultimately effect is not known, but the trials already made to determine this show very satisfactory results.

The best economy recorded in the annexed

Table 8.—Tests on a 300 H. P. De Laval Turbine. Conducted by Wilh. Jacobson.

No. of Test.	R. P. M.	Press at Stop Valve lbs. per sq in Gauge.	Vacuum in Turbine Cylinder. Inches of mercury.	B. H. P.	Consumption of Steam.		Superheat °F.	REMARKS.
					lbs. per hr.	lbs. per B. H. P. per hr.		
1	754.6	151		342.1	5 270	15.4	20	Installed in a Paper and Cellulose Factory at Pōtschmühle, Bohemia.
2	750.0	147		297.8	4,590	15.5	17	
3	760.0	143		252.6	3,960	15.7	20	
4	753.0	147		214.3	3 820	15.5	17	
5	750.0	154		165.0	2,640	16.0	10	
6	762.0	162		120.5	1.988	16.5	4	
7	762.0	162		74.5	1,476	19.8	4	
8	762.0	165		30.8	663	21.5	5	Exhaust at atmospheric pressure.

results of Parsons turbines occurs in the trials of a 1,000 kilowatt machine, built by Messrs. C. A. Parsons and Co. for the Newcastle and District Electric Lighting Company. The trials were conducted by Mr. Hunter, engineer for the Company. The vacuum was 26·5 in., the initial steam pressure 145 lb. per square inch (gauge), and the superheat, 237°F. The lowest consumption recorded, 17·7 lb. of steam per kilowatt hour, is equivalent to 13·2 lb. per e.h.p. per hour, or expressed in b.t.u. is 268 b.t.u. per e.h.p. per minute. Taking the combined efficiency of turbine and dynamos (there were two placed tandemwise), as eighty-three per cent., the calculated consumption of steam per i.h.p. per hour is 11·0 lb. This corresponds to a thermal consumption of 223 b.t.u. per i.h.p. per minute. This same turbine using steam at 138 lb. per square inch initial pressure (gauge), superheated 71°F., with 26 in. vacuum in the condenser, took 21·5 lb. steam per kilowatt hour. This corresponds to 16 lb. per e.h.p. per hour, or 300 b.t.u. per e.h.p. per minute. The advantages of superheating and the higher steam pressure are obvious.

TESTS.[1]

The best results to hand of trials on a Westinghouse-Parsons machine show a consumption of 12·4 lb. of steam per e.h.p. per hour. Taking the efficiency of the combined plant as above, the calculated steam per i.h.p. per hour is approximately 10·3 lb. This corresponds to 246 b.t.u. per e.h.p. per hour. These trials were made on a 1,500 kilowatt machine, with an initial steam pressure of 150 lb. (gauge), 140°F. superheat, and a vacuum of 28 in.

The trials giving this very low consumption were made by the Westinghouse Machine Company, who vouch for their accuracy, and the results are substantiated by three distinct tests.

The trials for the 1,000 kilowatt turbo-alternator, built by Messrs. C. A. Parsons and Co. for the city of Elberfeld, were made by Mr. W. H. Lindley and Professors Schröter and Weber. A complete account of these trials, which were very exhaustive, may be found in the *Revue de Mécanique* for November, 1900. The best consumption recorded — 19·43 lb. per kilowatt per hour—is equivalent to 14·43 lb. per e.h.p. per hour, or, assuming an efficiency of eighty-three per cent. for turbine and alternator, the calculated steam per i.h.p. per hour is 11·8 lb. The steam pressure was 129 lb. per (square) inch (gauge), with 18·4°F. superheat and the vacuum 28·2 in. The consumption expressed in b.t.u. is 270 b.t.u. per e.h.p. per minute and 264 b.t.u. per i.h.p. per minute, a result agreeing very closely with the previous one.

In the trials made by Professor Ewing on the 500 kilowatt Parsons turbo-alternator, at the Cambridge Electric Supply Company's plant, with a steam pressure of 145 lb. per square inch (gauge), vacuum 25·4 in., the consumption was 24·4 lb. per kilowatt per hour, corresponding to 18·2 lb. per e.h.p. per hour, or 274 b.t.u. per e.h.p. per minute. With the same assumption as above, the calculated consumption per i.h.p. per hour is 15·1 lb., corresponding to 225 b.t.u. per i.h.p. per minute. It is to be noted that in these trials the turbine was driving its own air and circulating pumps. The trials were made after the turbine had been in operation for one year. In the maker's tests, when the turbine was not running the air and circulating pumps, the consumption was 24·1 lb. per kilowatt per hour—*i.e.*, practically the same as after one year's operation.

The guaranteed efficiency of the turbines for the Metropolitan Railway Company's plant, referred to above—17 lb. of steam per kilowatt hour—is equivalent to 12·7 lb. per e.h.p. This corresponds to a consumption of about 10·5 lb. per i.h.p. per hour, or 213 b.t.u. per i.h.p. per minute.

There is very little data at hand concerning the economy of the Curtis turbine. A test made by the makers on a 600 kilowatt machine shows a consumption of 19 lb. of steam per kilowatt hour, the initial steam pressure being 140 lb. gauge, the vacuum 28·5 in. and no superheat. This is equivalent to 14·2 lb. per e.h.p. per hour, or, expressed in b.t.u., 269 b.t.u. per e.h.p. per minute.

In trials on a 10 h.p. De Laval turbine at Purdue University by Professor Goss, the best consumption recorded is 47·8 lb. of steam per b.h.p. per hour, corresponding to 805 b.t.u. per b.h.p. per minute. The initial pressure of the steam was 138 lb. per square inch (gauge), and the brake horse-power of the turbine, 10·33.

In a trial on a 50 h.p. De Laval turbine by Professor Cedarblom, of the Royal Polytechnic College at Stockholm, Mr. Andersson, assistant at the Royal Polytechnic College at Stockholm, and Mr. Uhr, Inspector of the Board of Trade, Stockholm, a consumption of 19·78 lb. of steam per b.h.p. per hour was obtained. The initial pressure was 122·3 lb. per square inch (gauge), and the vacuum 26·4 in. The thermal consumption is 352 b.t.u. per b.h.p. per minute.

In trials on a 300 h.p. De Laval turbine by Dean and Main, an average consumption for six trials is recorded of 14 lb. per b.h.p. per hour, corresponding to 272 b.t.u. per b.h.p.

per minute. The initial steam pressure was 207 lb. per square inch (gauge), the vacuum 27·2 in. and the superheat 84° F.

THE FUTURE OF THE TURBINE.

All things considered, it looks as if the steam turbine had made a permanent position for itself as a prime mover, and that it only needs time to extend its sphere of action. Probably the steam engine is the prime mover for nine-tenths of all the power that is developed, and any improvement producing a greater economy in its operation will have a powerful commercial influence. The reciprocating steam engine has apparently nearly reached its limits of economy. Although the turbine is not a perfect heat engine, when those improvements are applied that experience alone can suggest, it will, probably prove itself a more efficient machine than the reciprocating engine, and will mark one more step in the advancement of steam engineering.

There is a wide difference between the heat engines at present in commercial use and the perfect heat engine; and, although the thermal efficiency of the turbine is not as great as some internal combustion engines, the turbine, as it stands to-day, is a very simple and highly efficient steam engine. It is peculiarly adapted to the performance of certain kinds of work, and there is every reason to expect that those bright prospects for the future, which are indicated at present, will be more than realised.

The writer desires to thank the De Laval Steam Turbine Company and the General Electric Company for catalogues and information and especially wishes to express his indebtedness to the Westinghouse Machine Company, who through Mr. Duff, have placed photographs, results of tests and much useful information at his disposal.

Read before the Canadian Society of Civil Engineers.

THE DISINTEGRATION OF THE ATOM.

IT is well to proceed slowly in the radium question. The phenomenon of radio-activity has conjured up speculations that go to the very root of our preconceived notions as to the constitution of matter. The list of "elements" that occupied our earliest studies has, of course, received constant additions, but until lately the "atom" may be said to have dominated chemistry. According to the text books it was presumed to be "the least particle of an elementary body that was capable of entering into or being expelled from a compound."

The importance of the atom pales before the electron. According to the theory stated by Sir Oliver Lodge in his lecture at Birmingham, 300,000,000 of atoms could lie side by side in an inch, but to the electrons or small particles of electricity composing the atoms of matter are of such size that 100,000 of them could lie in the diameter of an atom.

We are told that the whole phenomenon of radium is intelligible and simple on the theory that radio-activity is due to atomic disintegration. On the screen was thrown a "portrait" of an atom of matter as nearly as it could be estimated, consisting of positive and negative electricity—the negative electrons in a state of violent movement with occasional possibility of escape. Sir Oliver Lodge remarked that the spontaneous breaking up of an atom constituted a novel source of energy larger than any previously known. The amount of energy of any weighable collection of atoms was enormous if it could be got at, but in practice only a very few atoms were unstable from instant to instant. Most behaved as if they were permanent; but they were probably none of them really and eternally permanent. The discovery of this new or intra-atomic energy affected their estimate of the possible life of the sun, and, to some extent, of the probable geologic age of the earth. But the most important consequence was the discovery of the mutability of matter, the transmutation of elements, and the liability of material atoms to break up or explode. Activity was the rule through the whole world of life, through the solar system and the stellar universe also. Birth, culmination, and decay were the rule, whether it were for a plant or an animal, or for a nation or a planet, or a sun. Nothing material was permanent. Millions and billions, aye, trillions of years it might last, but it was slowly changing, not merely the groupings, but the foundation stones (or atoms) themselves. The atoms were crumbling and decaying; must they not also be forming and coming to the birth? This last they did not know as yet; it was the next thing to be looked for. Decay only, without birth and culmination, could not be the last word. The discovery might not come in their time, but science was rapidly growing, and it might. Science was still in its early infancy; they were beginning to comprehend a few of the secrets of Nature; they were yearly coming nearer to some sort of comprehension of the mind and method infused into the material cosmos. They now knew things which had been hidden from the wise and prudent of all time. Surely somewhere there must be joy at seeing man thus entering into his heritage and realising these primal truths concerning his material environment, whereof he had been living in ignorance all these thousands of years.

The theory propounded by Sir Oliver Lodge opens up a new chapter, or a new *volume* of science, the far-reaching nature of which it is impossible to foresee, but despite the highly-coloured speculations to which the theory has given rise, we think he would be the last to claim that we are within measurable distance of the transmutation of metals.

The prize of 100,000 francs placed at the disposal of the Parisian press syndicate by M. Osiris has been divided between Mme. Curie, to whom 60,000 francs has been allotted, to enable her to continue her researches as to radium, and M. Branly, who received 40,000 francs for his discovery of the conductibility and non-conductibility of filings under the influence of the Hertzian waves, which rendered wireless telegraphy possible.

BUSINESS SYSTEM AND ORGANISATION.

BY

D. N. DUNLOP.

This series of articles is concerned with systems for organising factory labour on an equitable basis. The present instalment deals with accurate time-keeping, and includes some interesting particulars of the calculagraph. By way of illustration, the author has included some suggestive specimen cards. The previous articles were as follows: "The Provision of Labour" (April, 1903), "Stockkeeping and Recording" (August, 1903), "The Perpetual Inventory" (October, 1903). The next subject discussed will be the work of the Record Office.—Ed.

IV.—A SYSTEM OF TIME-KEEPING.

THE highest and most successful type of modern industry demands not only the finest mechanical equipment and the most competent labour staff in order to increase the quality and quantity of the output and the money-making capacity of the concern, but also an organisation that will enable the manager to know day by day whether the various departments are working at full efficiency, and whether the calculated profits on the product are real or only imaginary.

It is of vital importance that the manager should keep in touch not only with every part of the concern, but that every detail should be within his grasp; he must be aware of the strong and weak points, so that he may employ all the power, knowledge and experience available to strengthen the mighty machine of production, and enable it to work at an efficiency as near 100 per cent. as possible. The manager must keep his fingers on the pulse of the establishment.

ACCURATE COST-KEEPING *v.* GUESSING.

The first step in this direction is to adopt an accurate system of cost-keeping, but this alone will not suffice, unless the labour be thoroughly organised and supervised.

A flexible, accurate system of factory accounting is an exact science, and will show the details of gains and losses on the various products. A thorough system of factory records will provide, in addition, unerring indications of the exact working conditions and efficiency of all departments of the factory and office, which will enable the factory manager to check large unnecessary expenditures or heavy losses.

The man who does not know what the labour of his manufactured product costs him is reduced to guessing.

Most factory managers keep a careful record of the cost of material entering into the goods they produce; many have appliances of some kind for recording the time at which each employee enters and leaves the works; from his accountant he can usually ascertain the total amount of the output for the same period, and thus the average cost of labour may be computed.

But when inquiry is made as to the exact amount and value of every different kind of labour that is expended on any given job or operation, the usual practice is to estimate it. By tolerating such practice a large manufacturing business becomes nothing more or less than a huge speculation, having no reliable evidence of profit or loss until the annual inventory and balancing of accounts comes as a shock or a pleasant surprise. By means of a proper system of factory accounts and records, as soon as a piece of work is completed, evidence of its cost is forthcoming which enables the selling price to be fixed no longer as a speculation, but intelligently and wittingly.

As an instance may be quoted the experience of the general manager of a well-known and prosperous firm in America: "Owing to my plant having work to its full capacity, I recently farmed out a large order to another firm, agreeing to pay them for all especial tools necessary to be made, provided they gave me a price on the tools. They made the price at $154, after a day's discussing with their tool-makers, and informed me after the completion of the contract *that they must have lost heavily on the special outfit they made.* I did not doubt their statement, as our clock recorder had shown that our special jigs and fixtures, similar in every way, cost $268·67 for material and labour alone." The other manufacturer did not use a cost-keeping system; he only estimated the cost of production.

CLERICAL WORK SHOULD BE REDUCED TO A MINIMUM.

Labour, unless properly organised, is at the root of most of the difficulties and failures which make the factory manager's life a burden to him. In considering labour, we treat mainly of work, time and pay.

The chief consideration in organising factory labour is to eliminate all clerical work if possible from the factory departments, and certainly from the workman's duties. The workman is proverbially a "bad hand" at writing, and makes a trouble of it nine times out of ten; it takes him three or four times as long as it would any of the clerks or even the foreman.

The number of minutes thus wasted in a year in large factories by the workmen under the old system, and paid for and charged as productive labour, although there is no output during the time, would pay the salary of an extra clerk who would do all the workmen's clerical work and a great deal besides, leaving the men free to increase the output. The personal factor involved in carrying out any cost system may make or wreck its success, for the *human equation* is at times a source of grave inaccuracy. Whenever, therefore, it is possible to eliminate brain work and substitute machines which make no clerical errors, whenever by pulling a lever a correct result may be obtained where formerly an expensive and fallible clerk was required to make mathematical calculations, a decided advance has been made towards perfection of system.

Under the old system each employee was provided with a board on which he entered the nature of his work, the number of the order, and the time spent thereon. Suppose the workman has been employed on a dozen different jobs during the day if, as is usually the case, he makes up his time board at night, how can it be reasonably expected that he will remember how long he operated on each article. Again, the check, or token, system of time-keeping at the gate of the factory having but one entrance, and the different shops scattered about over acres of ground is a great disadvantage and loss to the employer. Some of the shops in large works are as much as five minutes' walk from the gate, which means that every man from that shop wastes twenty minutes every day between the gate and his work, which in a year means at least 15s. per man, or £75 for a hundred men; moreover, a workman once within the gates with his check or board in his pocket does not always walk briskly or go straight to his work.

How is this leakage to be stopped?

TIME RECORDERS.

It is clearly in the interest of the employer to install a system which shall be accurate, and the knowledge that his time is being recorded automatically against him sharpens the workman up and prevents his falling into lazy inefficient ways. The British workman is in the main conservative, and difficulty is often experienced in making him adopt and carry out new rules and regulations, or new systems in the workshops. The use of mechanical time recorders, however, has rarely raised any spirit of opposition among the employees, who can check its accuracy every time they use it, and know that its records ensure their being paid for every minute registered "in." Unless the works are small and compactly built, so that the gate is close to all parts of the building, a time recorder should be placed at the entrance to each shop. There is no fear that the workman will fear to register, or dawdle when inside the gates, for he soon gets to understand that upon these records only will the payroll be made out.

The recorder consists of an eight-day clock with a large clear dial, and contains mechanism for marking on the card slipped into the slot, the exact time in figures at which the lever was pulled. The best plan, it has been found, is to provide two time cards per man for each week, one ruled, for Monday, Wednesday, and Friday, the second for Tuesday, Thursday, and Saturday, so that the cost department or record office can post up the cards the next day. These cards are kept in racks at the side of the recorder, one rack for "in," and another for "out." When he enters the shop on Monday morning, the workman takes the card bearing his number from the rack, inserts it in the slot, pulls a lever, and when the card drops into the receptacle, he sees that the time stamped on it corresponds with the correct time on the dial; then he places the card in the "in" rack, and goes to the foreman to receive his work. When the men have passed out at night, the cards are collected by the time clerk, who also distributes the cards for the following day in the rack. It is thus possible at any time during the day to ascertain from the racks which workmen are in and which absent.

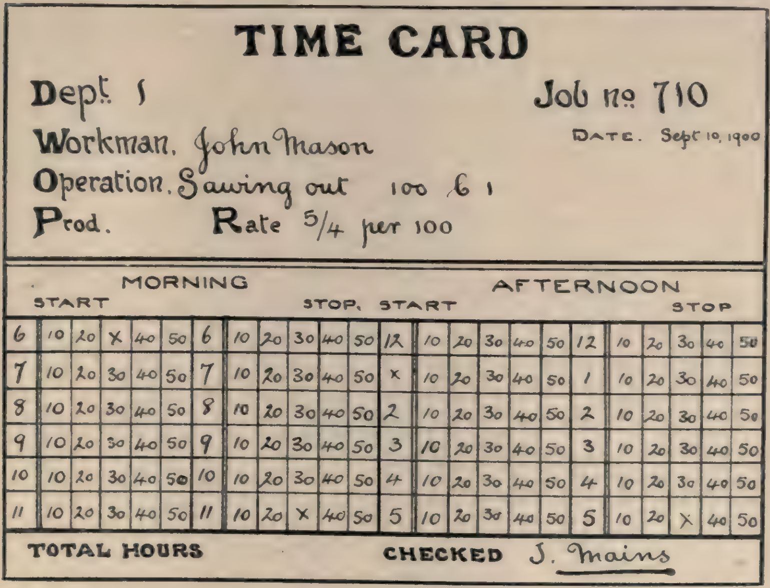
Many firms use a time recorder in all the shops for recording the exact time spent on a job by the workman (fig. 1). The most prolific source of error is doubtless in the method of recording time—time being the important element in computing the cost of labour. So well is the difficulty understood of obtaining exactness in the clerical record made in the old-fashioned way, when the workman is allowed to write down the time he spends on each job or operation, that many managers have detailed time-keepers to visit the individual employees frequently and regularly for the collection of such data. Experience, however, shows that the average clerk even does not accurately record elapsed time by means of pencil and clock dial, nor does he always rightly subtract time of day from time of day when posting up time recorder cards, and there is the added danger that when looking over a card containing times of commencing and times of stopping work, he may mix the records and subtract the wrong finishing time.

THE CALCULAGRAPH AND ITS FUNCTIONS.

The manufacturers who devised the calculagraph have made a great advance on all other systems of time recording. The ingenious calculagraph saves 50 per cent. or more of the time clerk's work by registering the time at which the job commenced, and mechanically subtracting this from the time of finishing; the difference or time elapsed is then printed in hours and minutes on the card dropped into the slot.

The calculagraph makes no clerical errors, and can be manipulated by anyone. It is only necessary to push a card into the slot and pull a lever, and the number of calculations this clever machine can make is only limited by the number of cards it is possible to push consecutively into the slot during a given time. A test recently made of a thousand calculations made by clerks of elapsed time, covering the work of 18 different time-keepers, showed that more than 20 per cent. of the records contained errors—some of them exceeding one hour. These tests were made by experts using stop watches; the calculagraph therefore will obviate the chance of any such errors. It may be had with or without a dial marking the time of day.

The ruling of the cards need not be exactly as illustrated here; this is merely an example of the kind of record made.



TIME CARD

Dept. 1 Job no. 710

Workman. John Mason DATE. Sept 10, 1900

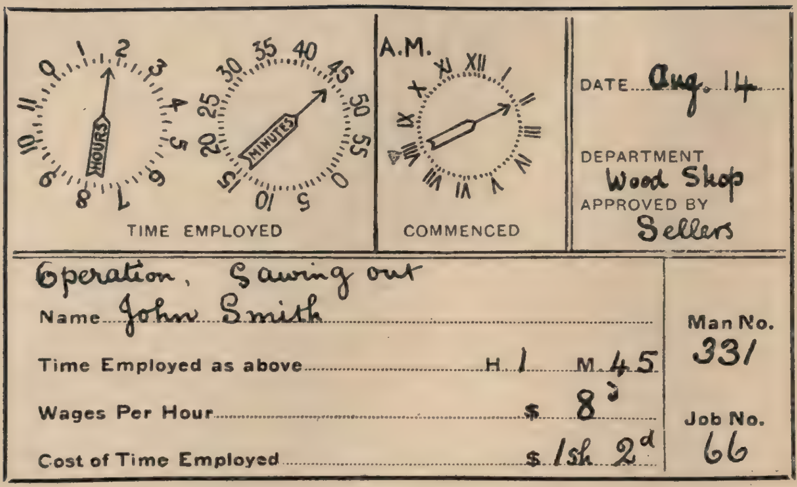
Operation. Sawing out 100 6 1

Prod. Rate 5/4 per 100

MORNING												AFTERNOON											
START						STOP.						START						STOP					
6	10	20	x	40	50	6	10	20	30	40	50	12	10	20	30	40	50	12	10	20	30	40	50
7	10	20	30	40	50	7	10	20	30	40	50	x	10	20	30	40	50	1	10	20	30	40	50
8	10	20	30	40	50	8	10	20	30	40	50	2	10	20	30	40	50	2	10	20	30	40	50
9	10	20	30	40	50	9	10	20	30	40	50	3	10	20	30	40	50	3	10	20	30	40	50
10	10	20	30	40	50	10	10	20	30	40	50	4	10	20	30	40	50	4	10	20	30	40	50
11	10	20	30	40	50	11	10	20	x	40	50	5	10	20	30	40	50	5	10	20	x	40	50

TOTAL HOURS CHECKED J. Mains

FIG. 1. JOB TIME CARD.
Old system with hand labour.


HOURS
MINUTES
A.M.
TIME EMPLOYED
COMMENCED

DATE Aug. 14

DEPARTMENT Wood Shop

APPROVED BY Sellers

Operation, Sawing out

Name John Smith

Time Employed as above H 1 M 45

Wages Per Hour $ 8^{d}

Cost of Time Employed $ 1sh 2^{d}

Man No. 331

Job No. 66

FIG. 2. TIME CARD.

Calculagraph system of mechanical recording.

The card (fig. 2) shows a specimen of the records made by a calculagraph. We find that John Smith, of the wood shop, began work on job 66 at 8.10 a.m. and was employed 1 hour and 45 minutes, which at the rate of 8d. an hour, the cost clerk computes at 1s. 2d. Each workman who operates on job 66 will receive a similar card in his own department, and if he be employed more than one day upon it, there may be several cards bearing his name or number.

It will be the duty of the foreman or his clerk to make out and issue these cards, and upon their return to forward them, after filling in the rate per hour, to the cost department of the record office. Meanwhile the stock-keeper has issued his card showing the stock or stores issued in connection with this order; when the job is completed the totals of labour costs in each department of the factory will be handled by the record office and charged to those departments. From the cards which reach the office the prime cost of the article manufactured will be computed by adding the proper percentages for factory expenses and general expenses, and from the manufacturing cost the selling price will be duly fixed by the manager and filed in a special catalogue cabinet.

The calculagraph may also be employed to keep a check on piece workers by registering the time spent on each job and providing data for fixing and maintaining a fair rate of pay. If a workman be granted leave of absence during business hours for any reason the calculagraph will show how long he is away. It may also be used in the absence of other time recorders, to record the workmen's daily attendance time, but for that purpose the time recorder is to be preferred, the great value of the calculagraph being found in the keeping of labour costs, where the accurate time employed in producing any article of manufacture affects not only the pay roll, but the selling price and profit made by the firm.

Special calculagraphs can also be had for industries or factories where the rate of pay per hour is uniform in the department, which print the value of the elapsed time in £ s. d. or other coinage. The calculagraph, therefore, obviates all necessity for clerical work on the part of the workman, besides saving half that of the time clerk. The production or cost cards supplied to the workman with all necessary data filled in either by the foreman's clerk or in some factories by the record office or cost department which is the better plan, are taken by him to the calculagraph to register when he commences a job and again when it is finished; he then gives up his card to the foreman, who checks it, and forwards it to the record office. The calculagraph thus does for him with absolute accuracy what two-thirds of the time he would but guess at. If the workman has given his employer the full value of the time for which he is paid, the calculagraph records or job cards for the day under his name and number, when totalled must exactly agree with the time on his attendance time card for the same day.

Another mechanical recorder, the "Dey" Time Register, recently further improved by the inventors, is entirely of British manufacture and possesses some distinctive features, the value of which many managers will appreciate.

(1) The workman never has access at any time to the records of the register, for there are no cards to be dropped into the slot as in the case of the Calculagraph and Rochester Recorder; but the men can see the record sheet through the plate-glass doors at the side, and check its accuracy. The "Dey" registers directly in bold type on a combined "Times and Wages Sheet" the exact time of the men's ingoings and outgoings, ready to be totalled and extended in the £ s. d. columns by the pay clerk at the end of the week.

(2) The "Dey" Time Register now makes a special feature of reproducing a facsimile of any works' time and wages sheets by combining the two ready for use on the register.

(3) By registering directly on the combined times and wages sheet, the various time and wages books or cards are dispensed with, and the pay clerk pays from the original sheet, on which each man has registered his own time—there can, therefore, be no dispute.

(4) By means of a clever attachment to the "Dey" the men can, in addition, record on cards for the cost department or record office, by means of the same machine, the time when they start and finish a job.

In appearance the "Dey" Time Register is compact, and the mechanism is wonderfully simple. It consists of a clock specially designed for the purpose, and of a dial indicating the days of the week, encircling which is a broad metal band, perforated by numerous holes corresponding with the numbers of the different employees (who may number from 50 to 200, according to the size of the "Dey" selected). All the workman has to do is to push the pointer, fixed by a pivot to the centre of the instrument, into a hole opposite his number on the metal band; the exact minute is instantly printed on a paper sheet attached to a revolving drum inside the machine, and a bell rings to indicate that the time has been duly recorded.

The ribbon which inks the type wheels is fed automatically, winding and unwinding by itself, and only requiring attention about once a year. No matter in what order the employees come in, or go out, the numbers are bound to appear in consecutive order on the time sheet. Another considerable advantage possessed by the "Dey," is that the time sheet is ready for the cashier to pay wages from, when it leaves the machine, without any transfer to other books; if desired a slip can be pasted in the wages book direct, a great saving of clerical work is thus effected. The record can be examined at any time through plate-glass doors at the side of the machine, and the presence or absence of any employee ascertained at a glance without moving the time sheet.

TESTING THE EFFICIENCY OF THE FOREMAN.

The calculagraph records not only place a check on waste of time by the workman, but form a severe test of the foreman's efficiency. There can be but one reason as a rule for any gaps in the workman's time, *i.e.*, the foreman had not prepared the next job for him before he registered "out" on the last; the foreman should deliver the fresh work and job card to the workman, see that he registers "out" and again "in" on the fresh card, and then O.K. his card. The foreman who allows no gaps is a valuable asset to the firm, and one of the most prominent factors when the cost cards are balanced every week or month because he places the workmen under his charge in a position where they can develop their full mechanical power in production that earns profits for the factory.

If any time be lost between the jobs, the time or cost clerk figures this out, and enters it on the workman's attendance time card (see fig. 2.)

The job card or time card (fig. 1) shows one of the best of the modern systems of registering labour without mechanical recorders, in which the workman's clerical work is reduced to a minimum. All he had to do was to read the time correctly by the factory clock, find the right time column, and cross through the numbers showing the time at which he commenced and stopped operation.

One of the chief benefits of the modern factory systems using cards exclusively for all records and accounts is that as all the cards are balanced daily, any discrepancy in time can at once be located, inquired into and explained; the shortages in time are then charged to the proper account instead of being padded out at the end of the fiscal year and charged to profit and loss, or to non-productive labour.

SELLING MACHINERY ON THE RAND.

We insert the following indictment for what it is worth, and shall welcome expressions of opinion thereon from South African readers.—Ed.

THE writer of an article which appeared recently in Page's Magazine emphasised the importance of the commercial side of engineering. The advantage of being a "commercial engineer" is still more apparent in South Africa, judging from the remarks of Mr. C. B. Pattrick, Government Inspector of Machinery for the Krugersdorp district, which were included as an appendix to Mr. Henry Birchenough's report.

It is remarked that while the British salesman is *either* an engineer or a business man, the American is *both*. The business instinct of the American manufacturer suggests to him the advisability of sending a man with the dual experience, the result being that he has only one man to pay, and every intending purchaser is much better satisfied because he can do all his business with one man instead of having to talk engineering technicalities with one and importing details with another. The extreme stiffness and rigid politeness of the British business man is not practised here, says Mr. Pattrick, but there is more warmth and geniality, and if a salesman wants to push business he must leave this smug respectability at home.

The American, like the Colonial, belongs to a new country, where independence of thought, self-reliance, and prompt decision are much more necessary than in an old country; these are traits which, apart from their special business training, make for success. The British system of training engineers is not complete. A pupil goes through the shops and afterwards into the drawing office, sandwiching in some theoretical schoolwork somewhere and is then turned out as an engineer and expected to make his living in the world. He may be an engineer pure and simple, and when more experienced he might do for a professor. This sort of man is occasionally useful, but what is wanted to advance the prosperity of the country is "commercial engineers," *i.e.*, those who, after studying engineering, have gone through a good general course of commercial work and afterwards returned to the engineering world or combined the two.

In England the idea of specialisation is overdone, the result being that each man gets into a rut from which he cannot extricate himself. The majority of commercial engineers one meets are men who, when their pupilage was finished, had never seen a specification and scarcely knew how to copy a letter; their commercial knowledge was picked up promiscuously afterwards, and the result is that the Old Country does not take the position she should because she has no class from which to draw competent technical salesmen.

Mr. Pattrick classes the British agent as a "brusque, blunt honest John sort of a fellow," while the American agent is "a genial and keenly diplomatic business man."

You leave the British agent with business only in your head and wondering if you have done right, whether he has not come out best. You leave the American agent scarcely realising you have been discussing business, with a warm feeling towards him, having had your pill so judiciously sugared that you scarcely realise that you have been taking medicine, and most probably prefer sugared tabloids to nauseous draughts.

A few details are mentioned which help the American to score, apart from any outside assistance. The most important point is that the Americans are experts in standardising, and the very simplest job is done by gauge.

The Depreciation of Factories, Mines, and Industrial Undertakings, and their Valuation.

By the EDITOR.

ALTHOUGH the subject of depreciation becomes every year more important and varied, it is a matter of regret that there is still no treatise on the subject by a professional accountant accustomed to deal with such affairs. Mr. Ewing Matheson is well advised in bringing out a third and much revised edition of his excellent handbook, which very creditably fills the gap.

Those interested in the question of municipal trading *versus* private enterprise would do well to study the author's remarks upon the subject of municipal depreciation, which grips one of the points often missed in this controversy. It is sometimes urged that as municipal works are generally maintained out of the rates, there is no need to write down their value or accumulate funds for their renewal. It is, however, well known that no mere system of maintenance will provide for that wasting of assets which takes place from many causes or contingencies. The system of municipal accounts generally requires to be placed upon a much sounder basis before it will be possible to state with certainty the exact position of a given undertaking, and in our opinion too little is often allowed for depreciation and sinking fund charges.

SHOULD ADVERTISING BE CHARGED TO CURRENT REVENUE OR CAPITAL ACCOUNT.

In travelling about the country we hear of many different methods of treating the expenses incurred in advertising at the year end, and we believe the general rule to be, to charge all such outlay to the revenue of the year in which it occurs. Such a prudent and thrifty principle, however, needs some qualification, as the author explains :—

> Advertising is hardly ever successful unless it is persistent, and it is a mistake to attribute results in any period to concurrent expenditure. From this point of view it would appear fair to charge some of the outlay to capital. To do this directly might be a dangerous course, as the advantageous effect of past outlay may at any time be diluted and speedily terminated by relaxing or discontinuing such expenditure. That is to say, as there is no tangible asset, it would be imprudent and unsound, unless with special safeguards, to divide as profit the increased income shown by charging forward some of the advertising outlay.
>
> But as advertising has been well compared to the sowing of seed for future benefit, the effect will survive for a while after the advertising is stopped. On this principle some firms charge two-thirds of their expenditure to a suspense account, which is written off in two subsequent years. When once this system has been applied for two years, the total annual charge is as though all current expenditure were charged to the revenue of the year in which it occurs, but there is always two-thirds of a year's outlay standing in the books as an asset to be paid for by new partners or shareholders who will reap the benefit of it. On this plan, if at any time the advertising ceases the asset is written off in two years, and the newcomer pays nothing for it, unless, indeed, the goodwill is still deemed to be enhanced by the past expenditure.

THE DEPRECIATION OF ELECTRICAL PLANT.

One of the most interesting portions of the book is the new section dealing with the depreciation of electrical plant. Those who have embarked capital in electrical plant with their own or other's past experience to guide them, have been assured by the sanguine inventor or engineer that finality has at last been reached, and that in regard to renewals or depreciation nothing need be considered beyond the mere physical wear and tear which attend all kinds of plant or machinery. As we all know, however, plant has sometimes to be abandoned, which is still in working order, but will fetch little when sold. It is obvious that, for some time to come, alterations and improvements will become unavoidable if the highest standard of efficiency is to be maintained, and it is now generally recognised that provision should be made for modernising the plant by some form of reserve. For a thorough discussion of the subject we must refer our readers to the book itself. Mr. Matheson's careful methods for fixing the rate of depreciation are well illustrated in the following paragraph :—

> An electric-lighting plant working an average of four hours per day is obviously not so highly strained as a factory-power plant working nine hours, or a tramway working eighteen hours a day. There are even some installations, both for public supply and for certain manufacturing purposes, where the machinery is worked continuously. Other operations, such as intermittent pumping in mines, may be confined entirely to night work if the power may be thereby cheapened. If it is desired to maintain a value in the books of account equal to the real value, a depreciation rate of 10 per cent. on the diminishing value would not be excessive, assuming, of course, that all

expenditure for minor renewals are defrayed out of revenue. Such a rate may, at any rate, be applied for the first few years till the efficiency of the machinery has been proved, and the likelihood of coming changes more easily estimated. The rate may then be reviewed and amended, but evidence should first be sought as to whether similar machinery has proved saleable after fifteen years' working at more than one-fifth of its original cost. If the actual sale of some of the plant in order to make room for a better kind is held in view, let the probabilities of selling a dynamo generator be considered, and the price which a user or dealer would pay for it. Experience up to 1903 showed that second-hand electrical machinery ten years old has seldom a saleable value except as scrap, although if left undisturbed it may last longer in its original place.

VALUATION.

In the second portion of the book the author has succeeded in bringing together upon the subject of valuation a large amount of practical information which is not generally available. The modern tendency towards large works in which labour-saving processes are extensively adopted, increases the amount of capital required for profitable working, and in valuing a works for a newcomer the past policy in regard to the purchase of plant is generally reviewed.

We regret we have only room for one extract:—

Labour-saving plant affording great advantages when in use is remunerative or otherwise according to the frequency of its employment. As examples, in an ironworks or factory a slow hand-crane in constant work may be a cause of daily loss not only in wages and repairs, but in waste of time. If such a crane be scrapped or sold for £50, and a new quick-moving crane worked by power installed at a cost of £500, the outlay may be entirely recouped in two or three years. If, after a few years' working, trade becomes dull, and the earning of interest on capital difficult, it would be unfair to treat as a burden the past outlay on the crane without taking credit for the savings already effected, the profit so earned, and for the permanent saving in time which, even in dull periods of trade, its use allows. Excessive timidity in anticipating adverse conditions would hinder all enterprise. If the past savings, instead of having been divided as profit, have been partly applied to a liberal system of depreciation, the permanent benefit of the outlay remains, while the capital has been written off. The value may prove to be permanent and should be paid for by a newcomer.

As a contrary example, a large or special machine showing great economy when at work may be so seldom required as not by its occasional savings to pay interest on the capital outlay, and a proper rate of depreciation. In this cases it would really have been better to retain an old and slower machine. As an extreme example, if an operation of lifting a very heavy weight occurs only once in five years, it may be cheaper to erect a pair of shear-legs on each occasion, even though the operation itself is much more costly than with a properly equipped crane. In short, while on the one hand it would be fallacious and unfair to judge all capital outlay by the measure of dull times, on the other hand, costly appliances may, as above described, sometimes prove a cause of loss rather than of gain. For instance, a factory may be constructed with an output capacity of one ton of product per week for each £100 invested, as compared with existing and smaller factories which have cost £120 per unit of output. Moreover, the labour in the new factory may be only £3 per ton of finished product as compared with £3 10s. in the older factories. But it is possible that this low cost can only be maintained when the factory is in full work, and that when it is only employed at one-half or one-third of its capacity, the proportions may be altered. The expensive labour-saving machinery must remain as a burden which cannot well be got rid of, while workmen may be discharged in the smaller factory. Factories so established may eventually repay those who can afford to wait, but without a large trade the burden of capital, especially if some of it be borrowed, is a frequent cause of failure. Ultimately, the profit is reaped by those who take advantage of the failure to buy the factory for much less than it has cost; and instances occur of a second or even a third change of ownership before the capital can be brought down to a sum on which the earnings will allow a profit.

Notable features of the book are the system of marginal notes and cross references, which we would like to see more generally adopted in other works of this kind, and the excellent graphic charts and tables.

"The Depreciation of Factories, Mines, and Industrial Undertakings, and their Valuation." By Ewing Matheson, M.Inst.C.E. Third Edition. E. and F. N. Spon (London). Spon and Chamberlain (New York). 7s. 6d. net.

NOTES AND NEWS.

THE Council of the Institution of Civil Engineers have nominated their President, Sir William Henry White, K.C.B., F.R.S., to fill the place of the late Sir Frederick Bramwell, Bart., as one of the representatives of that institution on the Engineering Standards Committee.

We are informed that Mr. Robert Mitchell, formerly Demonstrator in the Physical Laboratory of the Royal College of Science, South Kensington, and latterly with Sir George Bullough, of Messrs. Howard and Bullough, of Accrington, has joined the Directorate of the Phœnix Dynamo Manufacturing Company, Ltd., Bradford.

On Christmas Eve, Mr. Jardine, of Nottingham, together with Mrs. Jardine, entertained in the Meadows Hall over 1,400 of the children of the workpeople employed in Mr. Jardine's various factories.

An excellent programme was arranged, many of the items, such as songs, dances and recitations, being contributed by children of the workpeople, and over £100 was distributed in awards. This is the twentieth year in succession in which Mr. and Mrs. Jardine have entertained their workpeople's children.

The lightships at the Goodwin Sands are shortly to be equipped with wireless telegraph apparatus, placing them in communication with the Admiralty station near the Shakespeare Cliff at Dover.

The Lodge-Muirhead system of wireless telegraphy has been the subject of some exhaustive experiments by the War Office during the past six months, and the results obtained are said to have fully satisfied the Government experts.

The electrification of the Lancashire and Yorkshire Railway between Liverpool and Southport is proceeding apace. The original scheme has been somewhat extended, and nearly twenty-three miles of double line have been rendered available for electric traction.

The Great Central Railway Company has decided to follow the example of the London and South-Western and to signal its main lines by the low-pressure pneumatic system combined with electric track circuit. The work is to be begun at the Manchester end, where the traffic is heaviest, and the first installation is to extend from Ardwick Junction, near Manchester, to Newton Station, a distance of about six miles, for the greater part of which there are four lines of rails, besides numerous junctions and sidings.

Junior Engineering Society.

During the month an interesting visit was paid by members of the above society to the Stratton Drainage Works of the Highworth Rural District Council. The party were met by Mr. R. H. Buckley, the resident engineer (of the firm of Messrs. Beesley, Son and Nichols, engineers), who conducted them over the farm, and fully explained the process. Twelve filter beds are employed, and are arranged in two rows, the first and higher row being filled to a depth of two feet with coarse clinker, and the lower row having finer filling. The walls of the beds are of earth and clay puddlings. An upper bed, after standing filled for all twelve hours, is emptied into the lower one adjacent to it, agricultural pipes being laid on the bottom to carry the effluent off. The beds are left dry for about twelve hours after each filling to aeriate. From the lower beds it is drawn off, and flows along a trough, overflowing from this on to the soil. The whole process is effected by gravitation, and is designed by Mr. Dibden (late chemist to the L.C.C.). Mr. W. B. Winchcombe, of Wroughton Road, Swindon, is the contractor, and when completed (in two or three months' time), it is anticipated that this plant will be one of the best put down for the disposal of sewage.

At an ordinary meeting of the society an excellent paper on "Internal Combustion Engines" was contributed by Mr. B. Humphrey, A.M.Inst.C.E.

Eclipse Glazing.

Messrs. Mellowes and Co., Ltd., of Sheffield and London, have in hand the orders for the glazing on their imperishable "Eclipse" system the roofs of the following buildings:—

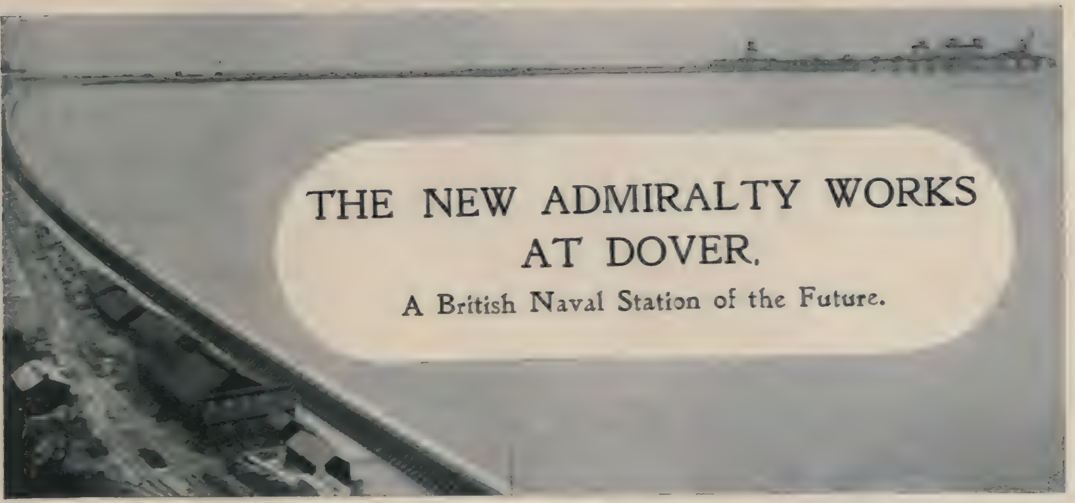
New Midland Station, Sheffield; three sub-stations for the Underground Electric Railways, London; erecting shop, Messrs. Marshall, Sons, and Co., Ltd., Gainsborough; Heysham Harbour Goods Shed, Midland Railway; Covent Garden Foreign Flower Market; Central Station Extensions, Glasgow; new fitting shop for Messrs. Head Wrightson and Co., Thornaby-on-Tees; new shops, Metropolitan Railway and Carriage Company, Ltd., Birmingham; new shops, Messrs. Greening and Sons, Warrington; Queen's Road car sheds, Sheffield Corporation; Woodford Station, Great Central Railway; extensions, British Westinghouse Company, Ltd., Manchester.

Bath Tramways.

The British Westinghouse Company have just done some quick work in connection with the above. On May 1st last ground was broken for the generating station, car sheds, and office buildings; and these have since been erected and equipped throughout. The generating station has a capacity of 675 kilowatts, and the car sheds hold forty cars. The complete electrical equipments for the latter consists of Westinghouse 49 B-90, with Westinghouse magnetic brakes. The Board of Trade inspection took place on Saturday, December 12th, that is to say, 7½ months after the commencement of the work.

Third Rail Dangers.

Concerning the operation of elevated trains by electricity, Mr. George Westinghouse is of opinion that there will be a complete revulsion of feeling in the electrical profession as to the necessity for the third rail. He points out that third rail danger may be entirely obviated by resorting to the use of overhead conductors, for which the elevated structure is peculiarly suited. It may seem to be heresy, says Mr. Westinghouse, to advocate the use of the overhead wire, but I venture to predict that there will be a complete revulsion of feeling on this point. When I speak of an overhead wire, I do not mean the slight construction which has prevailed, and the breaking down of which has occasioned trouble, but a substantial engineering arrangement so erected that it would, in fact, not be an offence to the eye.



THE NEW ADMIRALTY WORKS AT DOVER.

A British Naval Station of the Future.

THE RECLAMATION AND EASTERN ARM.

BY

A NAVAL CORRESPONDENT.

THE accompanying photographs, which we are able to reproduce by the courtesy of the Admiralty Works Loan Department, give an excellent idea of the progress which is being made with the scheme which is to provide Dover with a magnificent harbour of 610 acres, thus creating a new naval station on the south coast.

At this point, so important both from strategical and commercial reasons, the sea is often seen at its worst, and perhaps on no occasion has it put the work of the engineer to a severer test than during the great storm of September 10th last, when, although no damage was caused to the permanent works, an isolated temporary stage erected seaward of the east arm was completely demolished.

LONG CONTEMPLATED IMPROVEMENTS.

The accompanying plan will give a better idea of the scheme than a long description. The necessity for an enclosed harbour at Dover has been discussed ever since the appointment of a Royal Commission in 1840, to survey the harbours on the south-east coast, but the idea remained in a more or less nebulous condition until 1895, when Messrs. Coode, Son and Matthews were instructed to prepare plans for the present scheme.

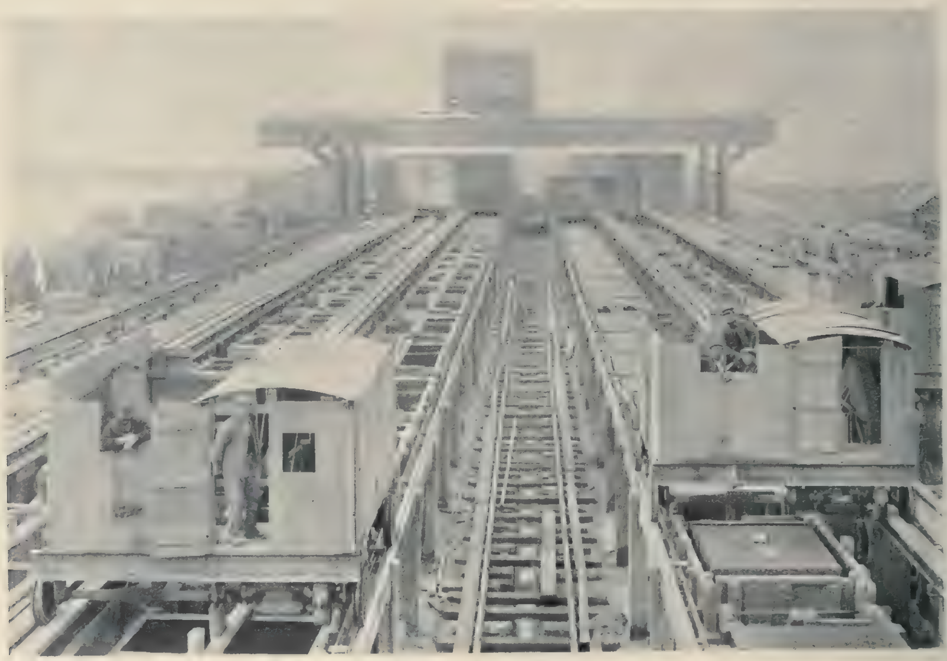
THE PRESENT SCHEME.

Their recommendations involve (1) the extension of the Admiralty Pier, completed in 1871, for a distance of 2,000 ft. in an east-south-easterly direction, thus practically doubling its length. (2) The construction of an eastern arm commencing a few hundred feet beyond the eastern boundary wall of the convict prison, and running in a direction approximately south by west for a distance of 3,320 ft. (3) An isolated breakwater, 4,200 ft. in length, running generally west by south, and east by north, but turning towards the north at its eastern end, and forming the southern protecting arm.

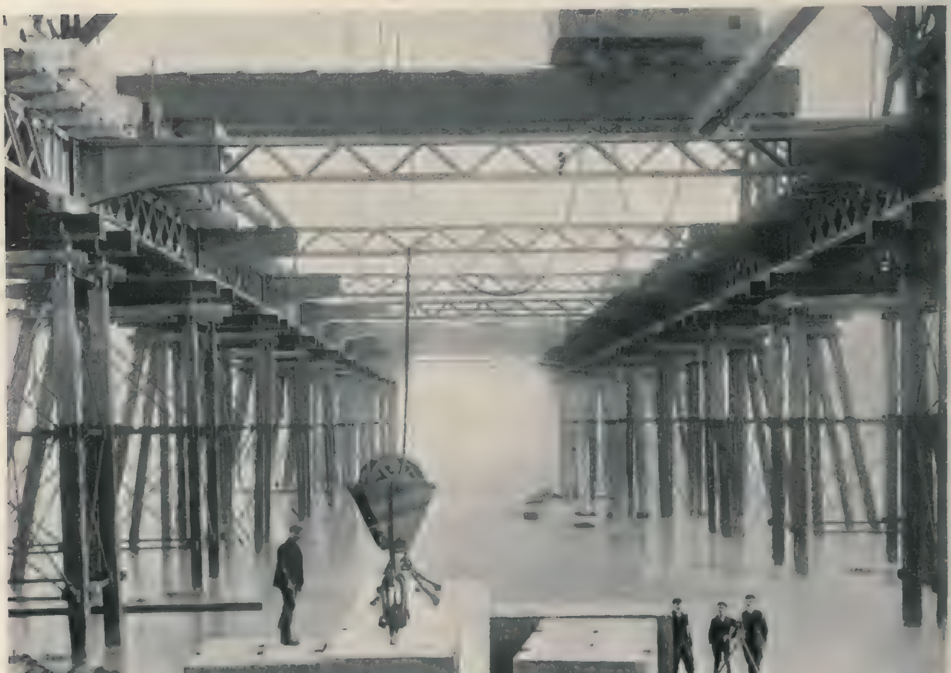
The contract for this scheme was let in 1897 to Messrs. S. Pearson and Son, and the works are being executed under the direction of Major Sir Henry Pilkington, K.C.B., R.E., the Civil Engineer-in-Chief, and Messrs. Coode, Son and Matthews, as chief engineers.

PROGRESS OF THE WORK.

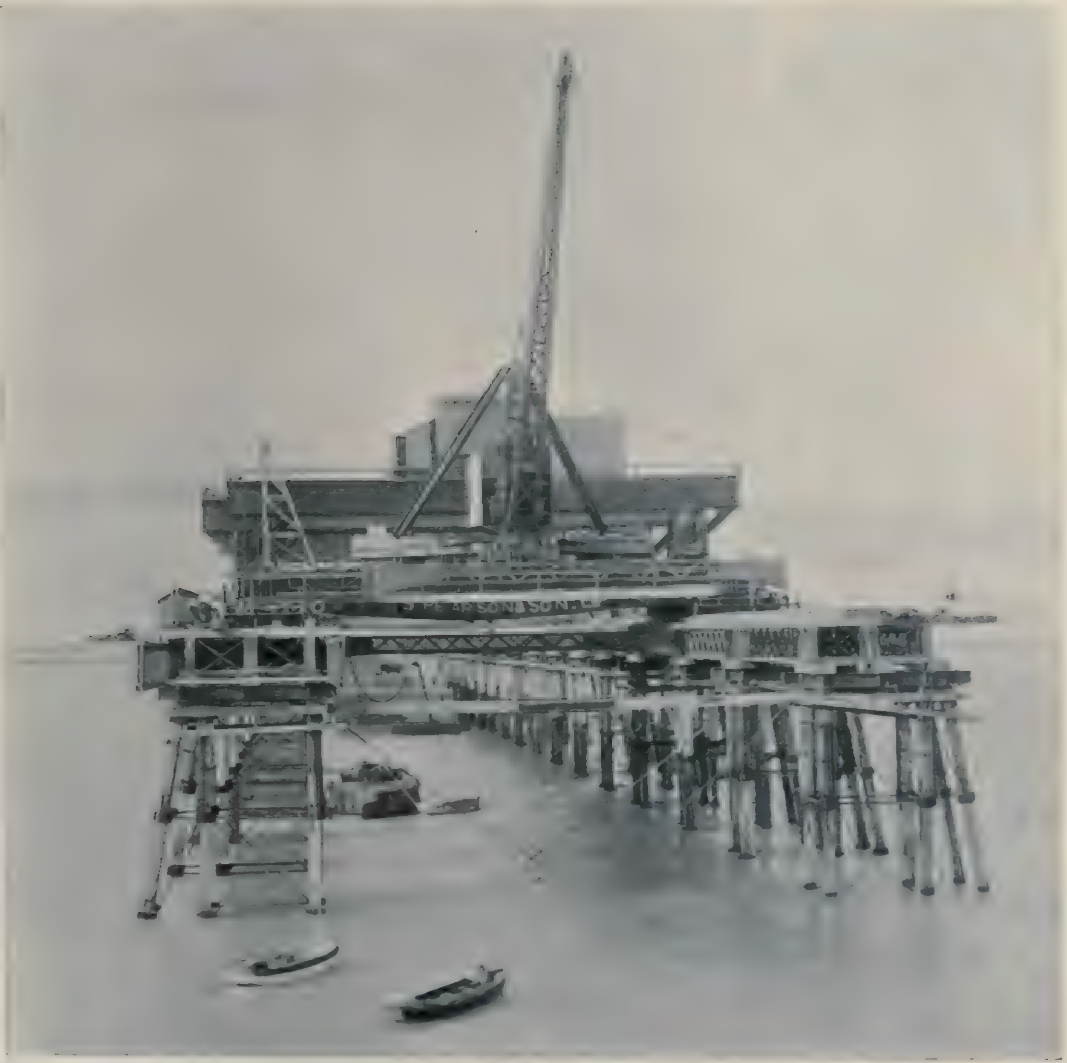
At the present time the Admiralty Pier Extension and east arm are practically completed, and the detached breakwater will be commenced as soon as the temporary stage has been sufficiently extended.



WORKYARD FORMED ON THE SITE OF THE RECLAMATION.
Here all the concrete blocks are prepared for the east side of the works.



EAST ARM AND TEMPORARY STAGING APPLIANCES.



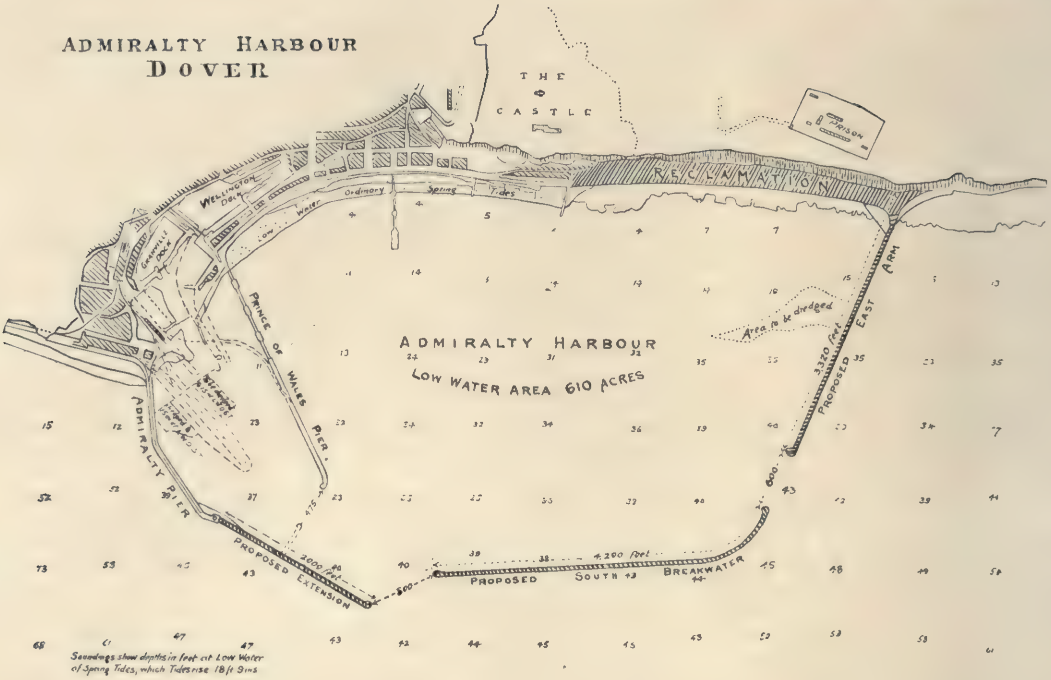
A VIEW OF THE TEMPORARY STAGING OF THE EAST ARM, TAKEN FROM THE SEA.

The general view of the extension, shown in the frontispiece, includes also the Prince of Wales Pier. Between these is the commercial harbour, in which the Dover Harbour Board intend to shortly commence further works for the accommodation of passengers embarking on or landing from large Atlantic liners.

It will be seen that entrances of 600 ft. and 800 ft. are provided at the extremities of the south breakwater, the Admiralty Pier extension being formed considerably south of the western end of the detached breakwater, in order to protect vessels which are entering the harbour when the tide is running with a strong current eastward.

The concrete blocks employed on the works range from 10 to 40 tons in weight. They were at first manufactured at Sandwich, but on the completion of the reclamation wall under the cliffs, part of the enclosed area having been filled in with chalk, scarped from the cliffs, was appropriated for concrete manufacture. A view of this workyard is shown herewith.

Powerful Goliath cranes are employed to work the grabs, which remove all loose material



overlying the chalk, and also for handling the large diving bell employed in the excavations, and for setting the blocks. The accompanying views of the east arm and temporary stagings will sufficiently indicate the nature of the appliances used and also the relative size of the blocks.

The latter are carefully bonded and are keyed together by joggles both above and below water, while from the low-water mark upward they are also set in Portland cement.

Under favourable conditions it is anticipated that the work will be finished in 1908. The estimated cost is about £3,500,000.

FRONT VIEW OF THE NEW BUILDINGS.

FAMOUS TECHNICAL INSTITUTIONS.

The second of a series of illustrated articles, giving brief descriptions of the most important technical institutions at home and abroad. The first of these described the Massachusetts Institute of Technology, and appeared in the January issue of PAGE'S MAGAZINE. In the present article Mr. Smith describes the power station of the university. A subsequent article will deal with the foundry and forge, the huge laboratories and workshops which will form what are called the main buildings, and the detail equipment of the mining and metallurgical sections.—ED.

II.—THE BIRMINGHAM UNIVERSITY.

BY

C. ALFRED SMITH, B.Sc., A.I.E.E.

PART I.

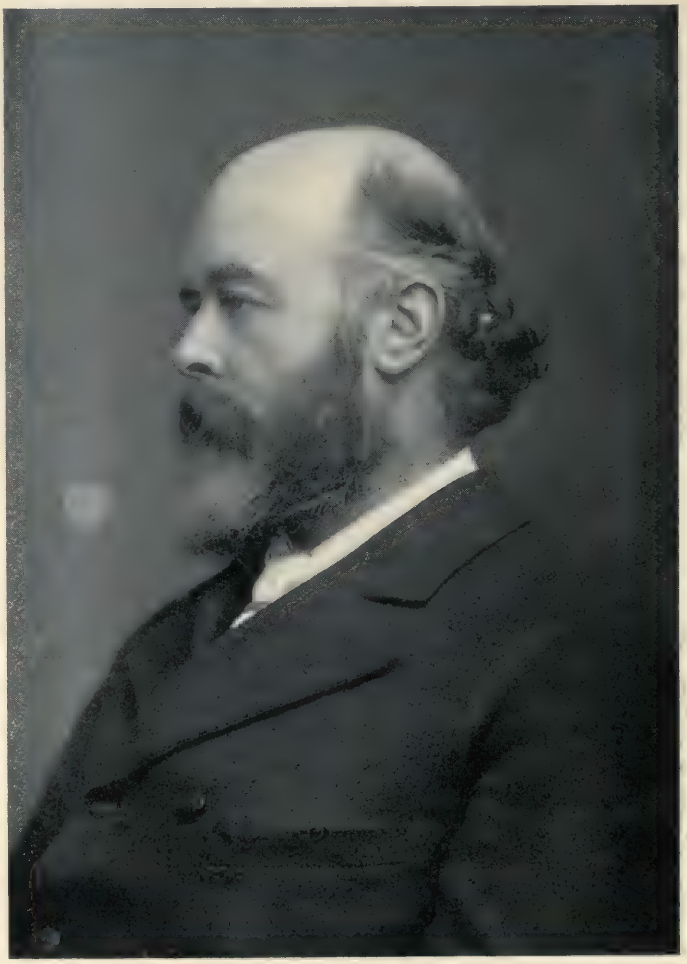
BETWEEN five and six years ago the public in the Midlands had placed before them the idea of a local university, with its headquarters at Birmingham. The prime mover in the scheme was the man to whom Birmingham owes so many great improvements, and who, during his three years of mayoralty, won for it the proud title, " the best governed city in the world," viz., the late Colonial Secretary and the first Chancellor of the University of Birmingham, the Right Hon. Joseph Chamberlain, M.P.

DEGREE DAY
The Chancellor leaves the University.

At that time probably not even the Chancellor himself foresaw the wonderful development which has grown from the original idea. With the remarkable perception of the events of the day which have made him so famous, however, he immediately grasped the fact that if this new university was to be famous, it must supply a demand and fill a gap in some branch of our higher education. It would have to be a useful education, one such as had not up to then been obtainable at the older seats of learning at Oxford and Cambridge, and it would have to be one which would have a distinct influence on local industries. In a word, it was to be technical education in which this university had to specialise to become of real service, both locally and nationally. The spirit of this early idea has been carried out to the letter and while the primary object of a university—that it is to be a seat of all learning and an establishment for the promotion of original research—has been always kept in view, yet the intention with which the promoters started has been ever present in their minds. This university of the Midlands was always meant to be developed in accordance with modern conditions and the needs of the great district for whose benefit it was founded.

At the outset the promoters were more

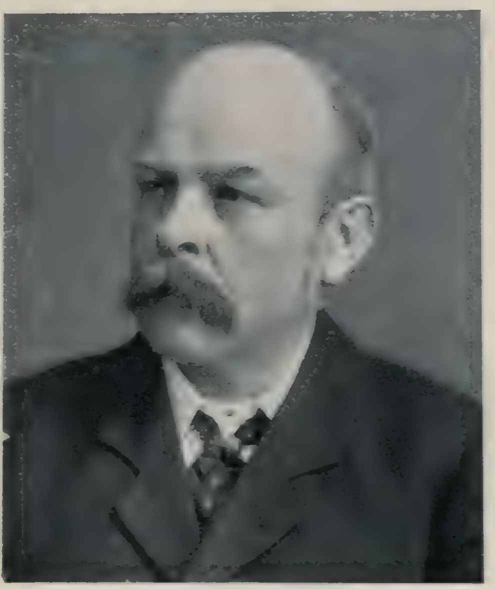
modest than they are at present. They only asked, then, for a quarter of a million of money, but they were soon convinced that at least £1,000,000 was wanted. To complete the scheme now in hand will require, it is thought, some £3,000,000. An early donor was Mr. Andrew Carnegie, who gave £50,000 and the useful advice that the Birmingham authorities should see what the United States and Canada were doing. Accordingly, a committee was appointed, consisting of Mr. George Kenrick, at that time Chairman of the Birmingham School Board, and now Chairman of the Education Committee and a member of the University Council, and Professors T. H. Poynting, F.R.S., Dean of the Faculty of Science, and F. W. Burstall, M.Inst.C.E., Professor of Civil, Mechanical, and Electrical Engineering. These gentlemen visited the States and Canada four years before the Mosely Educational Commission was thought of, and made a special study of the facilities offered there for technical education. The report which they presented on their return to the Council and Senate of the University, convinced these bodies that the state of higher technical education in this country was at that time not to be compared with that of the great nation across the Atlantic; also that it was urgent to build for the future. Owing to the generosity of a local landed proprietor, Lord Calthorpe, a site of thirty acres of land was then placed at the disposal of the University authorities. The position was not ideal, for the new site was two miles from the centre of the city, but there was a good train and tram service. And it was, of course, impossible to think of such a large tract of ground in the centre of the city. "Accordingly," said the Chancellor, recently, "we laid our plans for the great buildings which will be, we hope, a glory to the city and a worthy home for its University."



Yours faithfully
Oliver Lodge

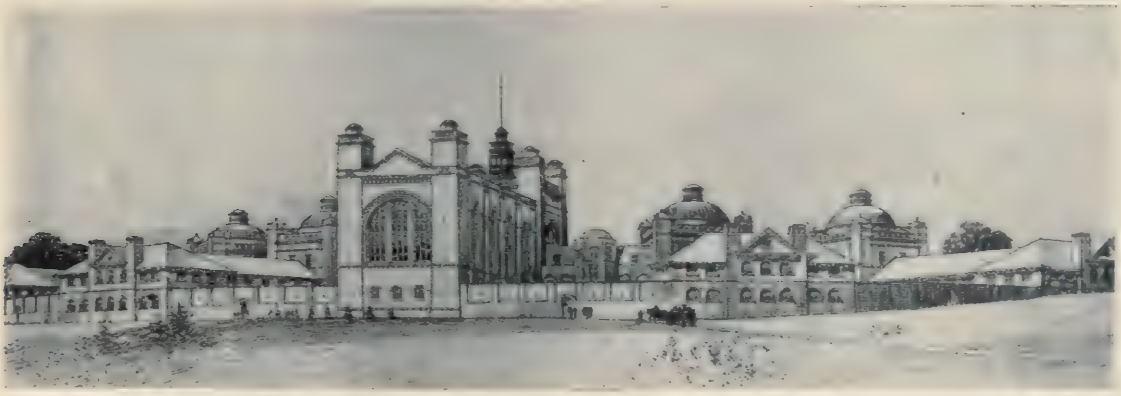
THE POWER STATION.

At the present moment there is erected at the new site at Bournbrook, a power-house for supplying electricity for light and power, and experimental purposes, and steam and gas for heating and cooking purposes, for use of the main buildings. This power-house consists of a boiler room 40 ft. by 60 ft., an engine room adjoining it 50 ft. by 100 ft. and a small drawing office and laboratory. The equipment of this place is unique, and has been entirely

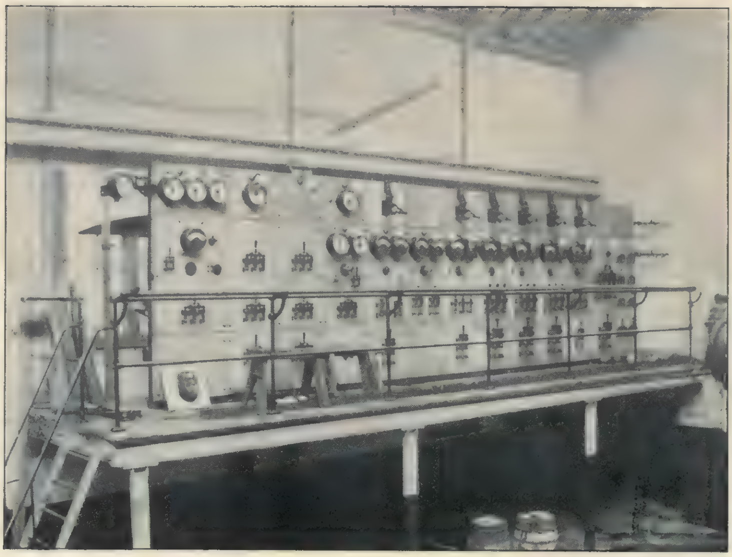


PROF. POYNTING, F.R.S.,
Dean of Faculty of Science.

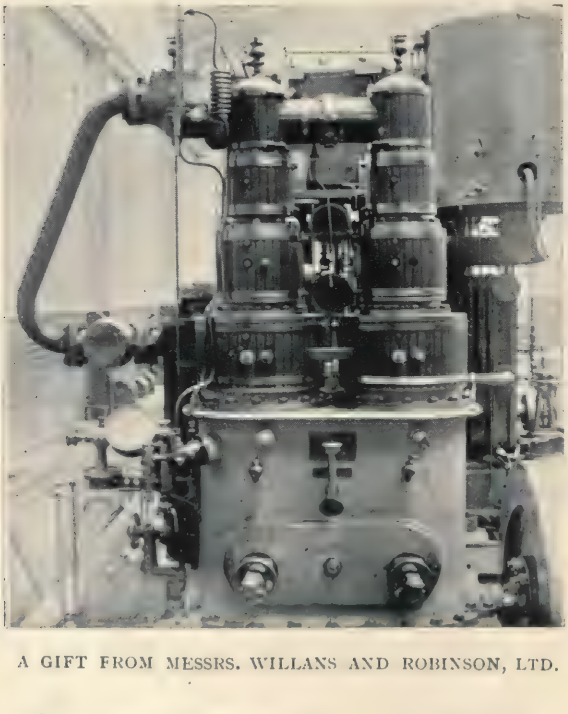
carried out, by the engineering staff of the university, according to the ideas of Professor Burstall. In the engine room are two quick revolution engines, each of 100 b.h.p., both being munificent gifts of two well-known Midland firms, Messrs. Willans and Robinson, and Messrs. Belliss and Morcom, Ltd. To the Willans set, is coupled a Siemens compound wound direct-current dynamo which generates 540 ampères at 110 volts. The Belliss' set drives a direct-current Bruce Peebles dynamo, producing 70 kilowatts at 110 volts—117 volts complete. The largest steam engine was built by Messrs. McLaren, of Leeds, and is a triple-expansion marine type running at 120 revolutions per minute. The cylinders of the engine are $9\frac{1}{8}$ in., $14\frac{1}{4}$ in., and $22\frac{1}{2}$ in. diameter and the stroke is 2 ft. The air and circulating pumps are driven off the h.p. cross head, and the condensing plant is on the same bed plate with the engine. A Westinghouse three-phase alternator is direct coupled to the engine and gives 75 kilowatts at 220 volts, with a frequency of 30 cycles. A turbine supplied by Messrs. Greenwood and Batley, of the famous De Laval type, is situated between the Belliss and Willans sets, and the dynamo is driven by speed reduction gear of 10 to 1 at 2,000 revolutions. The output of this machine, which is direct-current, is 27 kilowatts at 110 volts. The remainder of the steam plant consists of a horizontal Ruston Proctor experimental engine, which drives, by means of a belt a direct-current generator of 15 kilowatts. The engine was originally used in the old heat laboratory at Edmund Street, and forms the only connecting link between the old order and the new. It is a compound engine, the h.p. cylinder being fitted with Corliss valves, while the l.p. works with an expansion valve gear. In addition to this list of steam engines, there are the gas engines, one by the Premier Gas Engine Company, of Sandiacre. The dimensions of this engine, which has been built to Professor Burstall's specifications, are of interest, for on it will be done the bulk of the experimental work for the gas engine research committee of the Institution of Mechanical Engineers. It is a single cylinder type, 24 in. diameter, driving a direct current Westinghouse generator, and $2\frac{1}{2}$ ft. stroke, water jacketed and piston water jacket, positive scavenger type. There is also a three-cylinder vertical gas engine by the British Westinghouse Company. It drives, direct coupled, a direct-current generator by



BACK VIEW OF THE NEW BUILDINGS.



SWITCHBOARD AT THE POWER STATION.



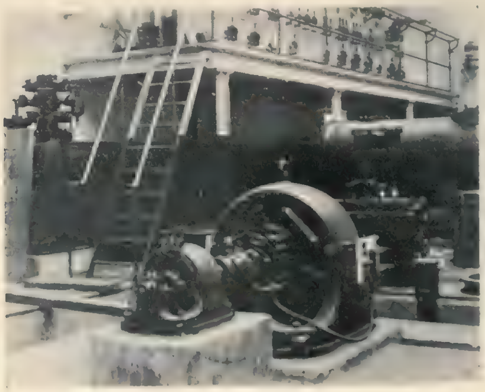
A GIFT FROM MESSRS. WILLANS AND ROBINSON, LTD.

the same company, giving 37½ kilowatts at 110 volts. There is also a steam-driven Worthington air compressor, capable of 25 cubic feet of free air against pressure of 200 lb. A Diesel oil engine of 10 b.h.p. is used (the guaranteed consumption being ·53 lb. oil per b.h.p. hour) to drive by means of a belt an ammonia refrigerating machine by Haslams, of Derby. The condensing plants are by Messrs. Worthington and Weir, and are of the ordinary Marine pattern. The speciality of the Weir condenser is that two pumps are used—one for air at the top and the other for water below. The main switchboard consists of thirteen panels, of these four are A.C., seven D.C. and two artificial load made of vermont marble copper mounting. The cables throughout the station were supplied by Messrs. Glover, and are laid in cement troughs and covered with bitumen.

A rotary converter completes the machinery equipment of the power station. This is 37½ kilowatts capacity and will work in either direction having a separate exciter on the end of the shaft.

At one end of the station there is a bank of lamps which will be used as an artificial load. By a special arrangement on the switchboard, these lamps may be used for the direct-current load or the three-phase alternating-current load. The steam piping in the engine room is very elaborate in order to allow any engine to be using steam from any boiler. It is supplied by John Spencer, of Wednesbury, and has lap-welded piping and welded flanges.

The equipment of the boiler room when complete will consist of one Babcock and Wilcox boiler (and superheater), a locomotive, a Niclausse and two economic boilers. At present only the two first mentioned are in place, but the others are either on order or will shortly be ordered. A special feature of this boiler



THE POWER STATION ROTARY CONVERTER.

THE POWER STATION COOLING TOWER AND FOUNDRY.

room is a gas-fired superheater—of Easton's type—and so arranged that the amount of superheat may be regulated by altering the quantity of gas supplied. Special arrangements have been made to read the superheat temperature on a dial with a pointer. The boiler room is designed for extensions, and is at present not so long as the engine room. Induced draught is obtained by a fan at the foot of a stack, the height of the latter being 100 ft. For supplying the gas for the gas engines and superheater there is a Mond gas plant capable of gasifying 5 tons of coal per twenty-four hours or producing over 29,000 cubic feet of gas per hour. This gas plant is situated just outside the power station, and since it is in close proximity to the metallurgical laboratory it is probable that it will also be used for heating purposes. There is a cooling tower for the circulating water, supplied and erected by Worthingtons, but built by the Klein Engineering Company, of Liverpool, for cooling the circulating water for 1,200 lb. steam per hour. There is also a large cooling pond for this water.

The power station will be running in the new year, and already several of the senior students have been doing erecting and fitting work there.

THE POWER STATION ENGINE AND BOILER ROOMS.

THE FOUNDRY AND FORGE.

Adjacent to the power station are two buildings, similar in structure to it, but of somewhat smaller dimensions. One of these will be divided into two shops, the foundry and forge. The other is devoted to metallurgical work.

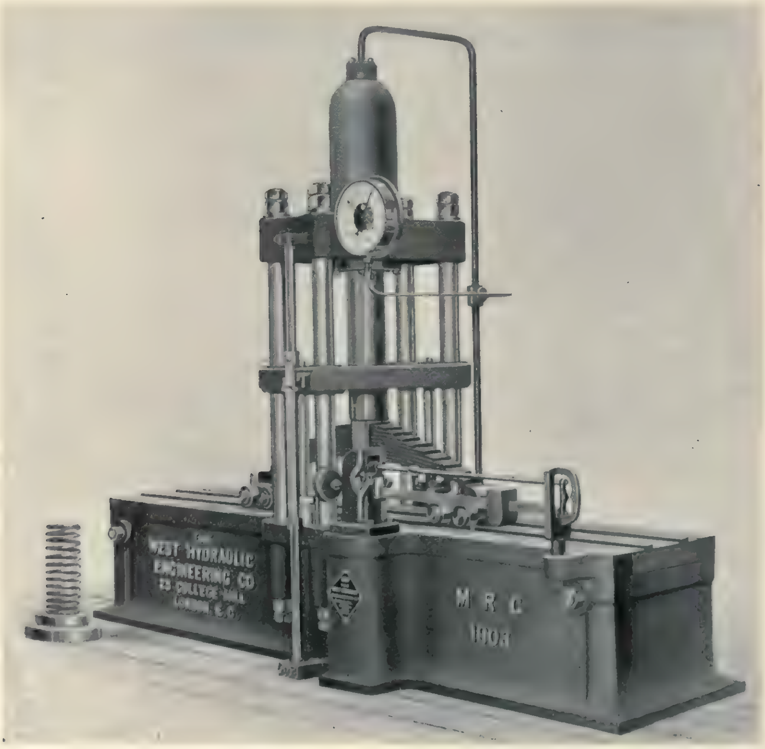
(*To be continued.*)

NEW MACHINERY.

Spring-Testing Machines.

SPRINGS of various forms enter largely into the construction of rolling-stock for railways, and it is of importance that each spring, forming part of a set, should be of the same strength and show the same resilience as the remainder, This is more especially the case of springs used in the under-frames of locomotives and passenger-coaches, travelling at high rates of speed, where every endeavour is made to reduce the vibration caused by the passing of the wheels over rail-joints, to a minimum. Even with springs of the best design and highest grade it is not possible to entirely absorb all vibration, and consequently indiarubber buffer-blocks and on some railways pneumatic appliances are employed to attain the desired end.

Railway companies and manufacturers of rolling-stock are naturally careful in the selection of springs to be used under their vehicles, and specify the amount of deflection each spring has to show under a series of loads. In order to be convinced that the springs supplied actually fulfil the conditions of the specification, a certain percentage of the springs are tested in special machines where the load, usually applied by an hydraulic ram, can be accurately measured by a steelyard and poise-weight, and the deflection noted. In some machines the only way to arrive at the deflection is to measure with an ordinary rule the height of the spring under each load and then deduct these heights separately from the original height of the spring. This is not a method to be recommended, as the necessary calculations may occasionally allow an error to creep in, and the same remarks apply to those machines in which no provision is made for mechanically deducting the weight of the spring and the holding appliances from the indicated load. A convenient and practical spring-testing machine should embrace the following features: (1) The load must be capable of being read direct from the steelyard without having to subtract the tareweight of spring and carriers from the gross load indicated by the steelyard. (2) The deflection of a spring under load should be read from the scale without respect to the original height of spring and without having to make any mental calculations. (3) The machine must be so arranged that springs can be tested under actual working conditions; that is to say that laminated springs with rolled eyes can be tested on scroll irons and shackles, arranged at the same distance between scale-bolts and with the shackle-plates at exactly the same angles as on the shackles on vehicle frame; the inclination of shackle-plates having a somewhat marked effect on the deflection of spring-plates. Springs without eyes should have small roller-carriages to carry the ends; or the ends can rest on the top of the machine-table. Spiral and volute springs must be tested on a subsidiary table, capable of a certain degree of, almost frictionless, rotation; otherwise the friction will cause the springs to appear stiffer than they really are. Spiral springs should be tested on a loose-fitting mandrel to prevent injury to operator, in the event of a spring breaking under test. (4) The weighing mechanism of the machine should be readily accessible, and at the same time be protected from dirt and grease. (5) The operator should have the whole of the indicating and controlling apparatus so arranged as to be at one side of the machine.



SPRING TESTING MACHINE BY THE WEST HYDRAULIC ENGINEERING CO.

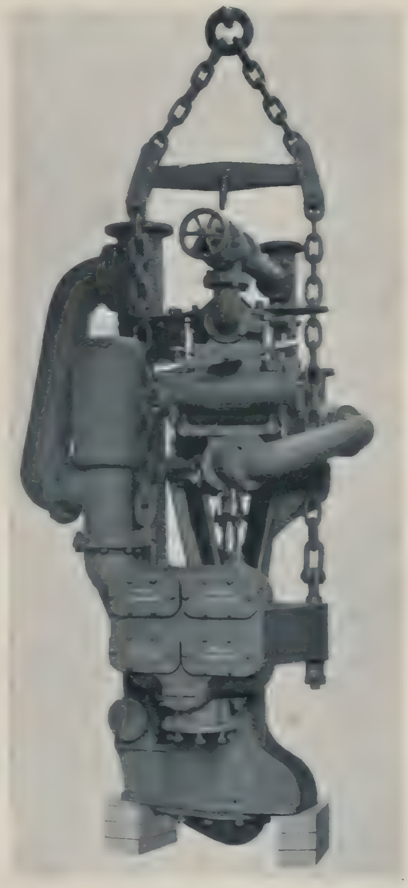
The accompanying illustration shows one of the most interesting products recently turned out by the West Hydraulic Engineering Company. It is completely equipped for testing laminated, volute, and helical springs. The machine was originally designed to meet a specification of the Madras Railway Company, whose consulting engineers, Messrs. Hawkshaw and Dobson, furnished several suggestions which assisted in the evolution of the machine in its present complete form. The machine, which is most conveniently worked from hydraulic pressure mains, but can also be actuated by power-driven or hand-pump, consists essentially of three distinct elements, viz., the loading, weighing, and indicating portions. The load is applied by a brass-lined hydraulic ram, working in a cylinder connected to the base by four steel columns, which also act as guides for the crosshead. Two gunmetal rams are employed to return the main ram.

The weighing apparatus consists of a heavy box section bed-plate and table, and the usual system of compound levers working on hard steel centres. The table is planed and provided with rails for the wheels of the small carriages seen in fig. 1. If, however, it is required to test spiral spring or volute springs, the same ball-bearing plate, seen on the floor at the left-hand corner of the engraving, is placed in position on the table, and the centre of this plate is recessed to take one end of a mandrel, which passes through the spring, and enters into the main ram, which is bored to receive it.

The indicating apparatus comprises the steelyard and deflection-scale. The former is of the double pattern, and the weight of spring and carriages can be balanced on the upper bar, and the load on spring read exactly on the lower. If preferred, however, the tare of spring, etc., can be counterbalanced by moving the special weight on a screwed extension of the bottom steelyard.

The deflection scale is of novel design. A square bar is fixed between an extension bracket on base and the entablature. On this bar slides a long, bronze fitting, carrying an engraved German silver rule. This rule can be raised or lowered on the bar, and locked by a small binding screw with milled head. On the same fitting is a pointer connected to a block sliding in a vee rod, with a friction spring. The working of this apparatus is as follows: the pointer block is raised until it is stopped by a tappet on the ram cross head, and the scale-bar is then adjusted until the pointer is on the zero line, and a turn of the milled screw locks the rule in its place. When the machine is started and the spring is depressed, the tappet on the crosshead moves the pointer, which gives a reading of exact deflection in either sixty-fourths of an inch, or in one-hundredths of the scale, which is marked in tenths, and the pointer is replaced by a Vernier. When the ram is raised, the pointer remains in the same position, so that there is no excuse for an incorrect reading. The weighing levers can be readily got at by screwing an eye-bolt into the table, and connecting same to crosshead, the power of the side rams being ample to raise the table. When in position the table protects the internal parts from dirt and scale.

The machine shown on the previous page was designed for springs up to 8 ft. long and 15-ton load, and the ram has a stroke of 20 in.



SPECIAL TYPE OF VERTICAL SINKING PUMP
BY MESSRS. TANGYES, LTD.

A New Sinking Pump.

This "special" type of Vertical Sinking Pump is arranged so that it can be made to do its duty when suspended on chains in the pit shaft.

The bottom cover of the pump is hinged so that it may be swung back enabling the bucket to be taken out when required, without entirely removing the cover. The water end is fitted with a removable liner.

The pump illustrated has 21 in. steam cylinder, 10 in. pump, and 24 in. length of stroke. It is made strong enough for 400 ft. "head," and has a capacity of about 20,000 gallons per hour. It will be noticed that bolts have been used throughout wherever possible, in preference to studs, and the glands are fitted with T headed bolts.

One of these pumps, which are manufactured by Messrs. Tangyes, Ltd., was exhibited at the Colliery Exhibition.

The Guarding of Circular Saws.

About four years ago a good many complaints were made in the press by practical people, who felt that some of the saw guards then available were positively obstructive and dangerous, while others failed to give adequate protection. The "Ideal" type of saw guard of Messrs. M. Glover and Co., saw mill engineers and patentees, of Leeds, which is here illustrated, has altered all that. Almost all discussion as to the alleged impracticability of saw guards may be said to have ceased, and what is more to the point, official statistics prove a great reduction in the number of accidents by circular saws.

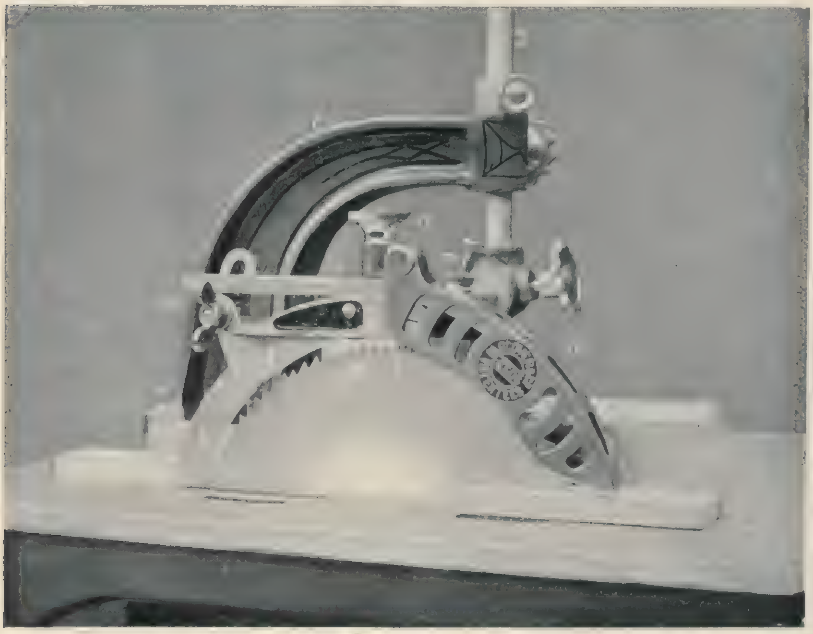
These "guards" may now be seen in Government exhibition offices, museums, intelligence bureaux and institutions of various nations, to which they have by request been officially supplied as recognised standard inventions, and our illustration is from a photograph of one of these.

The guard is of brass and steel, neatly designed and finished. Its chief feature is its accurate adjustability, and as this, of course, is a most vital point in the construction of a saw guard, it may be useful to explain how the various adjustments are arrived at.

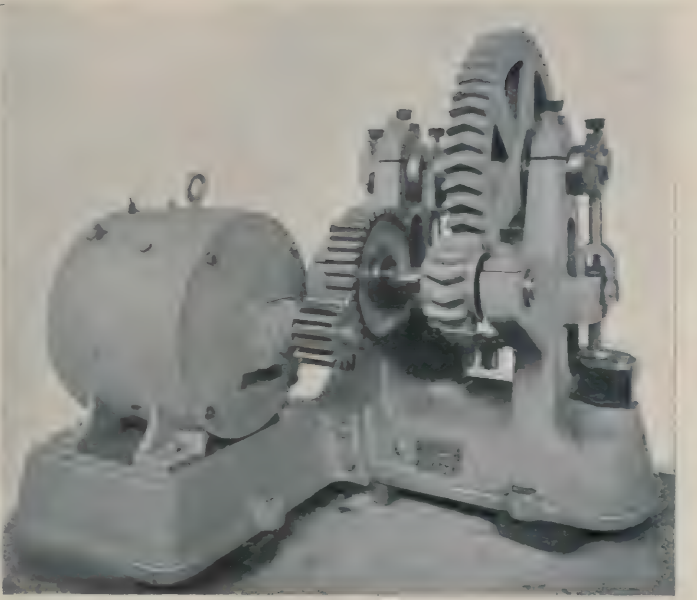
The illustration shows that a slightly *larger saw* than the one fixed may be used with the same guard by (1) raising the vertical shaft, 3, in the bracket which raises the whole guard; (2) by screwing down the milled screw, M, held by a lock nut on the top of the hood or front guard, which raises the front of the guard, thus assuming a larger circle; (3) by unscrewing the wing nut, W, and slightly raising the thin steel back blade with radial slot, 7, and (4) by pulling back the rack knife, 6, to admit of the larger diameter of saw, and which back knife is held firmly by a simple device underneath the table top.

In order to cause the "Ideal" guard to collapse circularly to fit smaller sizes of saws the reverse means are used, and all the adjustments can be almost instantaneously made. The vertical shaft, 3, is first lowered, carrying the guard down close to top of saw. The milled screw, M, is then unscrewed until the front hood, 12, falls on to the curved end of the tilting holder, 9. The tilting holder, 9, is next tilted up, thus raising the end, which is shown resting just above the "wing nut," and allowing the front hood, 12, to come lower or nearer to the centre of saw to suit the smaller saw desired, there being a simple "hinged bolt," 15, the round head of which just shows underneath the "tilting holder" almost vertically above the centre line of saw and this bolt fixes the "holder" in the required position. It is then necessary to unfasten the wing nut, W, and lower the "blade," 7, with "radial slot" to suit the saw, 7, after which the "back knife," 6, is moved closer to the smaller saw and fixed in position by a thumb screw under the table top. The bracket, 1, must be bolted to the table to allow of the shaft, 5, supporting the guard being fixed above and exactly central, and parallel with centre line of saw spindle, and the "back blades" or "knives" must be exactly in line with the saw. These are made of fine steel halved together at the joint to prevent obstruction.

It will be readily seen that the "front hood," 12, bearing name can be at once lowered or raised, is held in position on the T slide on "tilting holder," 9, by means of the small hand wheel, 11, and bracket, while by a turn of the "wing nut," W, which is on a T headed bolt, the "back blades" can be immediately disconnected from the brass portions of the guard, which can be swung round if desired for any particular purpose, and swung back again into exactly the same position by means of the safety collar on shaft, 3.



STANDARD "IDEAL" SAW GUARD.



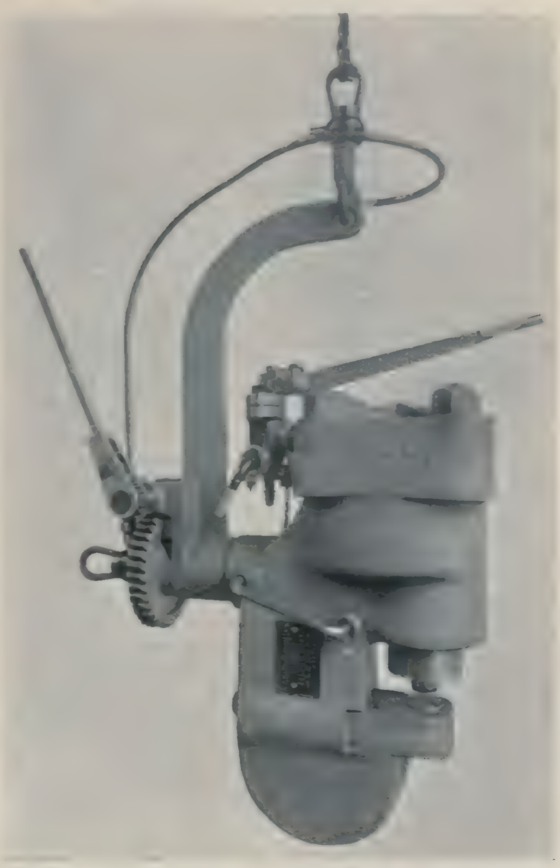
MOTOR-DRIVEN THREE-THROW PUMP. BY MESSRS. RICE AND CO., LTD., LEEDS.

Standard Motor-Driven Pumps.

We illustrate a standard type of motor-driven three-throw pump made by Messrs. Rice and Co., Ltd., Leeds. This pump is capable of delivering 390 gallons per hour at a pressure of 1,000 lb. per square inch, and the arrangement of three plungers gives an even delivery of water. The pump bodies and valves are of phosphor bronze, and are connected together to feed through one branch. The base of the pump standard forms the tank from which the pumps draw water. A cast-iron bedplate is bolted to the side as shown, and on this is carried the motor for driving. This motor is of the enclosed shunt wound slow speed type, and is capable of continuously developing 3½ b.h.p. at 220 volts and 500 revolutions per minute. On the end of the motor shaft is keyed a raw hide pinion, which gears into a machine cut spur wheel on the pump countershaft. The second motion is of the double helical type, and consists of a cast steel pinion on the countershaft, and a cast-iron wheel on the pump crankshaft. A starting switch is provided by means of which the pump can be automatically started and stopped from the hydraulic accumulator, or other machine to which it is desired to connect the pump. Special brushes are fitted to avoid any trouble through sparking, while every attention has been paid to the details of both pump and motor in order to ensure efficiency and reliability.

Boiler Riveting Machine.

With the introduction of boilers in which the end plate is flanged outwards for the flues, it has been found necessary to manufacture a special form of riveting machine for closing the rivets round the furnace mouth, and the illustration shows a type of machine for this special purpose which has been designed by Messrs. Rice and Co., Ltd., Leeds. The machine illustrated gives a pressure of 60 tons on the rivets, and is made very short over the cylinder so as to go into a flue of 2 ft. 3 in. diameter. The holder-up, which must be small enough to pass between the narrow place, where the two flues are close together, is a separate forging of high grade steel recessed into the steel body casting, and secured by a mild steel shank, which passes through the body, and is fastened by a nut on the back of the riveter. The holder-up is supported underneath by the frame casting as far as is possible to clear the flue flange when riveting. The whole machine can be easily adjusted round the complete circle by a mild steel worm and machine-cut worm wheel arranged on the hanger as shown.



BOILER RIVETING MACHINE. BY MESSRS. RICE AND CO., LTD, LEEDS.

THE SHIPBUILDING OF BELFAST.

LAST year Messrs. Harland and Wolff beat their own record—which is saying a good deal—reaching the enormous output of 110,463 tons, this being an increase of 30,966 tons on the record of the previous year, and 18,147 tons in excess of the total for 1901.

For the last three years the firm has sent out "the largest ship" for the time being, and it will therefore be surprising if the *Baltic* is allowed to retain this record permanently.

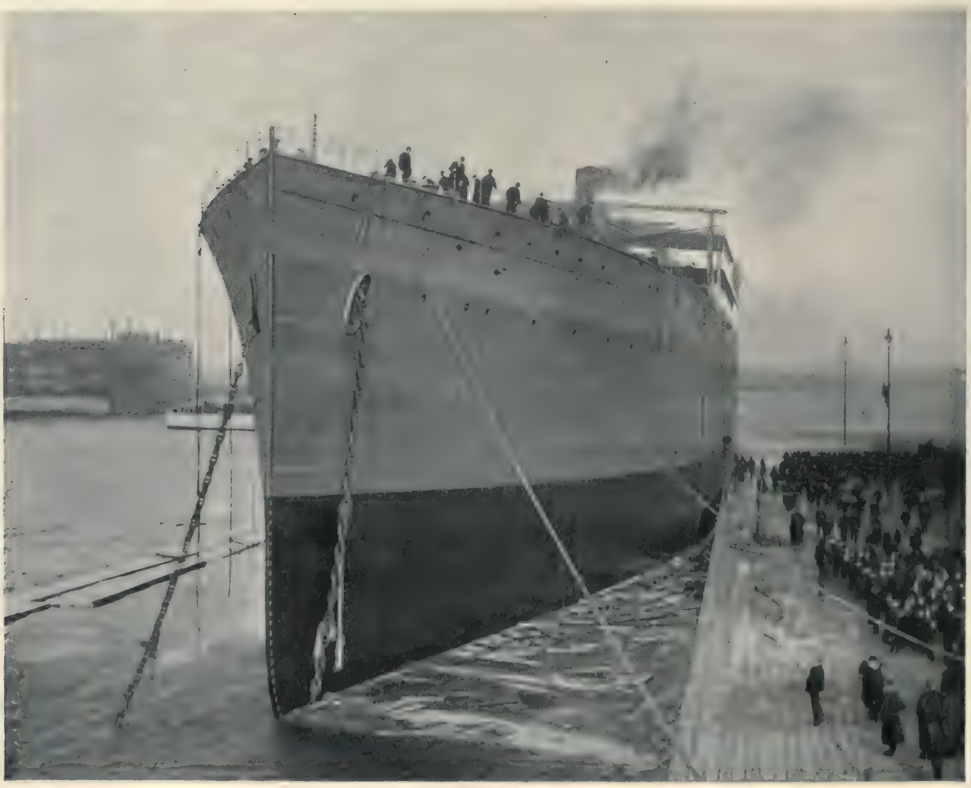
Of some thirty vessels of 12,000 tons and upwards built by British firms, Messrs. Harland and Wolff contributed twenty-four vessels of 351,422 gross tons, or an average of 14,643 tons each. The following is a list of vessels built by Messrs. Harland and Wolff of 12,000 tons and upwards :—

Name.	*Gross Tonnage.*		*Gross Tonnage.*
Pennsylvania	13,333	*Minnetonka*	13,398
Cymric	13,096	*Athenic*	12,234
Oceanic	17,274	*Walmer Castle*	12,546
Saxon	12,385	*Corinthic*	12,231
Minneapolis	13,401	*Ionic*	12,232
Minnehaha	13,403	*Cedric*	21,035
Commonwealth	12,097	*Arabic*	15,860
Runic	12,482	*Columbus*	15,500
Suevic	12,500	*Kenilworth Castle*	13,150
Celtic	20,904	*No.* 353	16,780
Ryndam	12,527	*No.* 354	16,780
Moordam	12,531	*Baltic*	23,763
		Total..	351,422

The following is a list of vessels of 12,000 tons and upwards built or building by all other builders, British or foreign :—

Name.	*Gross Tonnage.*	*Builders.*
Campania	12,950	Fairfield.
Lucania	12,952	,,
Ivernia	14,058	C. S. Swan and Hunter
Carpathia	13,555	,,
Saxonia	14,281	J. Brown and Co.
Pretoria	13,234	Blohm and Voss.
Potsdam	12,522	,,
Blucher	12,334	,,
Graf Waldersee	13,193	,,
Moltke	13,335	,,
Deutschland	16,502	Vulcan Company.
Patricia	13,424	,,
Kaiser Wilhelm der Grosse	14,349	,,
Kaiser Wilhelm II.	19,360	,,
Kronprinz Wilhelm	14,908	,,
Grosser Kurfurst	13,182	F. Schichau.
Kaiser Friedrich	12,480	,,
Kroonland	12,760	W. Cramp and Sons.
Finland	12,760	,,
Mayflower	13,507	Hawthorn Leslie.
Manchuria ..approx.	13,300	New York Shipbuilding Company.
Mongolia	13,300	,,
Minnesota ..approx.	21,000	Eastern Shipbuilding Company, New London.
	322,246	

Twenty-three vessels ; average, 14,010 tons.



MESSRS. HARLAND AND WOLFF'S LATEST LEVIATHAN—THE "BALTIC."

A VIEW OF THE YARROW CONVALESCENT HOME.

The Yarrow Home for Convalescent Children at Broadstairs.

THE Yarrow Home for Convalescent Children of the Better Class at Broadstairs has lately, by the desire of its founder, Mr. A. F. Yarrow, M.Inst.C.E., come under the control of the Institution of Civil Engineers in the following manner: The Home and its endowment fund have been vested in trustees appointed by the Council, the first trustees being Sir William White, K.C.B., President Inst.C.E.; Sir John Wolfe Barry, K.C.B., Past-President Inst.C.E.; and Sir Alexander Binnie, Vice-President Inst.C.E.; with Mr. A. F. Yarrow. The Council have also undertaken to appoint, from time to time, as may be required, the members of the Managing Committee of the Home, it being a condition that the committee shall in future be composed wholly of members of the Institution of Civil Engineers, and, in respect of two-thirds of them, of past or present members of the Council of the Institution, or of the Committee of Management of the Benevolent Fund of the Institution.

It is anticipated that, incidentally, the children of engineers and members of their staffs, who are not in affluent circumstances, should be very greatly benefited by the changed conditions under which the Home will be conducted in the future.

The Home is a model of orderliness and comfort, and since its inauguration has been of incalculable value in ameliorating the lot of juvenile sufferers. The seventh annual report which is before us shows that during the year ended December 31st, 1902, the total number of children admitted was 942, of whom 451 were boys and 491 girls; among these being 145 children who had lost either one or both their parents. Since its opening in August, 1895, something like 7,000 children have passed through the home as follows:—

		Number admitted.	Average number.	Average length of stay.	Number of "child-days."
For the year 1896	...	553	46	31 days	17,082
" " 1897	...	601	52	31 "	18,569
" " 1898	...	947	70	27 "	25,409
" " 1899	...	938	72	28 "	26,433
" " 1900	...	939	73	29 "	27,427
" " 1901	...	1,040	80	28 "	29,023
" " 1902	...	942	80	31 "	29,239

The following table is an abridged statement of income and expenditure during the six years, 1897-1902:—

		Income.				Expenditure.		
		£	s.	d.		£	s.	d.
1897	...	3,699	10	0	...	2,728	19	6
1898	...	3,898	11	5	...	3,821	17	10
1899	...	3,997	1	1	...	3,928	5	6
1900	...	4,088	16	7	...	3,963	0	1
1901		4,276	15	2	...	4,569	15	8
1902	...	4,421	17	5	...	4,461	4	4

The Yarrow Home is likely to be of incalculable value to the profession, and will also serve as a standing record of the keen interest taken by Mr. Yarrow in the interests of the profession.

The above information and illustration of the home we owe to the courtesy of Dr. J. H. T. Tudsbery, Secretary of the Institution of Civil Engineers.

OUR MONTHLY BIOGRAPHY.

SIR JOHN WOLFE BARRY, K.C.B., F.R.S, LL.D.

THE youngest son of the late Sir Charles Barry, R.A., architect of the Houses of Parliament, Sir John Wolfe Barry was born in London in 1836. He was educated at Trinity College, Glenalmond, and King's College, London.

His professional career was commenced by a pupilage under Mr. (afterwards Sir John) Hawkshaw, to whom he subsequently became assistant, and, on the completion of the Charing Cross and Cannon-street Railway Bridges and Stations, in connection with which he had been resident engineer, he commenced practice independently as a civil engineer.

Photo by Alfred Ellis and Walery.]

SIR JOHN WOLFE BARRY, K.C.B., F.R.S., LL.D.

Many of our most important public works bear the stamp of the genius of Sir John Wolfe Barry, notably The Tower Bridge, on the successful completion of which he was made a C.B., while in the Diamond Jubilee year he was promoted to K.C.B., and received the honour of knighthood.

Among other important works carried out by Sir John Wolfe Barry may be mentioned the completion of the Inner Circle Railway through the City of London from the Mansion House to Aldgate, and the extension to Whitechapel, the building of St. Paul's Station and Railway Bridge at Blackfriars for the London Chatham and Dover Railway Company; the immense Barry Docks and large system of railways in connection therewith; the King Edward VII. Bridge at Kew; and extensive dock extension works at Grangemouth, Tyne Dock, Middlesbrough, Bristol, and Surrey Commercial Docks.

He acts as consulting engineer to the Caledonian, London Chatham and Dover, Metropolitan, Metropolitan District, and Barry Railway Companies; also to the Bridge House Estates Committee of the Corporation of London, the Commissioners of the River Tyne, the Surrey Commercial Docks, the Regent's Canal and Dock Company, the Bengal Nagpur Railway, and the Bombay Port Trust.

In the course of an exceptionally active career, Sir John Wolfe Barry has given his time unstintedly to the public service in various directions. He served on the Royal Commission on Irish Public Works, and on the Commission on the Western Highlands and Islands of Scotland; also on two Commissions which were appointed by the Board of Trade to deal respectively with the estuaries of the Ribble and of the Thames. He, with Sir Charles Hartley, K.C.M.G., represents Great Britain on the Suez Canal International Commission for Works. He was a member of the Royal Commission on Accidents to Railway Servants, and on the Board of Trade Committee on the Vibration of Tube Railways. He is a member of the Royal Commission on London Traffic, and of the Court of Arbitration appointed under the Metropolis Water Act, 1902, for the purchase of the London Water Companies.

Sir John has for some years shown an active sympathy with the Volunteer movement. He is a Lieut.-Colonel in the Engineer and Railway Volunteer Staff Corps, and a member of the Army Railway Council.

For two successive years (1897-98) he was President of the Institution of Civil Engineers, and in 1898 and 1899 filled the Chair of the Society of Arts. He has taken a great interest in Technical Education and is a member of the Senate of the University of London, Chairman of the Executive Committee of the City and Guilds of London Technical Institution, and a member of the Council of King's College.

He was mainly instrumental as President of the Institution of Civil Engineers in 1897-8, in securing the adoption by the Council of the system of examinations for admission to the Institution, and also in the inauguration and development by means of a representative committee of a system of Standardisation for the Engineering Trades of Great Britain.

His contributions to the technical press include "Railway Appliances," 1874-92; "Lectures on Railways and Locomotives," 1882; "The Tower Bridge," 1894.

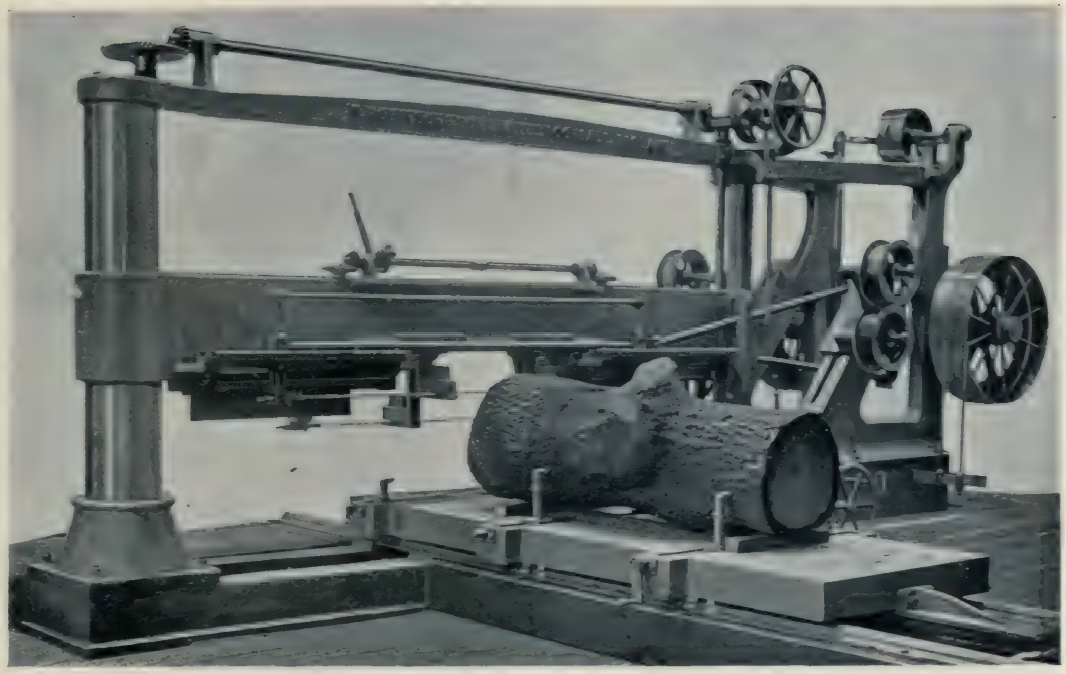


FIG. I. DOUBLE HORIZONTAL SAW FRAME.

A TYPICAL INDIAN SAW MILL PLANT.

BY

HORACE A. GASS (*Indian Forest Service*).

The saw mill here described is an interesting example of the use of water power in India, and illustrates the great advantages possessed by the Pelton wheel, where a reasonable fall and a sufficient supply of water can be obtained.—ED.

THE Anaimalais, or Elephant Hills, of Southern India, are in parts covered with extensive deciduous forests, containing large supplies of valuable timber trees. Fires in past years have caused such injury to the standing stock that the quality of the timber is very inferior, and the logs are now almost without exception unsound, with heartshakes, decay, twists, knots and cracks. This affected the selling price so much, that it was decided to abandon log sales, and to establish a plant for working up the timber in the forest, so that only sound wood in saleable sizes might be sent to the markets.

A small river flows through these forests, falling in one part over a ledge of rock 86·75 ft. high from crest to foot, and creating, what is locally known as, the Tunakadavu waterfall.

Above this fall, the catchment area of the river is about four square miles. The average rainfall is between 50 and 60 in. during the S.W. and N.E. monsoons, scattered over the months, June to January. From the end of January till the middle of June the rainfall is almost nil; the river dries up, the whole forest becomes unhealthy, and work is suspended.

The scheme was to construct a dam above the fall and lead the water through a channel to a point above the river as far as necessary below the waterfall, to secure a fall of not less than 100 ft., and to establish a saw mill by the side of the river, and work it by water power with a Pelton wheel.

THE DAM.

The dam is of masonry, built upon, and into, the rock. It is nearly 80 ft. long, 8 ft. high, 4·5 ft. thick at the base, and 2·75 at the top, and is provided with masonry wing walls backed by earthen banks, raised 4·5 ft. above the dam level, and above any probable flood. A pool is formed about 700 ft. long, of an

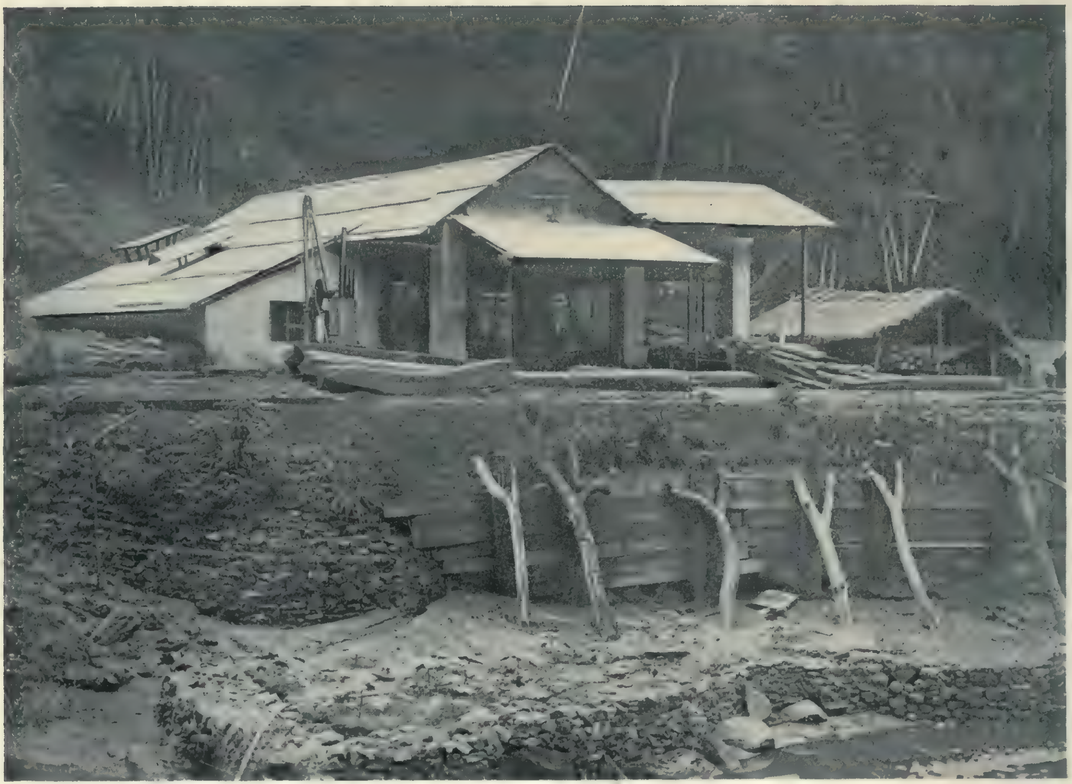


FIG. 2. EXTERIOR OF THE MOUNT STUART SAW MILL.

average width of about 40 ft., and a depth of 5 ft., giving a supply of about 140,000 cubic feet of water. During rainy weather the inflow exceeds the quantity consumed in the mill, and the water flows steadily over the dam. After a prolonged period of fine weather, the water decreases a foot during a day's work, but the pool fills up again during the night.

THE SLUICE AND CHANNEL.

The water runs through a tunnel in the left hand wing wall, the entrance to which is provided with an iron shutter, raised by a screw.

The dug channel is 2,385 ft. long, of an average width at bottom of about 2½ ft., with sloping sides. In a few places, where excavation was found to be impracticable, and where ravines had to be crossed, masonry walls have been built. The channel follows the contour of the ridge, and has a fall of 1½ in. per 100 ft., giving a velocity of about 100 ft. a minute. The water runs about 12 in. deep, and the volume is from 250 to 300 cubic feet a minute. The channel is provided at its lower end with a second sluice-gate, which can be closed when the water supply is short, to back the water up in the channel, when the mill is not working. The water passes over a wooden flume into a cistern which contains the pipe head, and is provided with an opening at the back to carry off the surplus water into the overflow channel.

THE PIPE-LINE.

The vertical fall of the main pipe-line is 125·64 ft. and its length 250 ft. The pipes are riveted steel, tested to a pressure of 100 lb., with socket and spigot joints, and coated with a bituminous composition, which increases their durability. The bell-mouthed pipe-head is 16 in. in diameter, that of the upper half of the pipe-line is 12 in., and of the lower 10 in. The pipes are laid along the surface of the ground and covered with earth. At every 50 ft. they are securely anchored.

An air-pipe is tatached just below the bell mouth, and to prevent small stones and *débris* from entering the pipes the cistern and pipe-head are each protected with two layers of wire netting of fine mesh.

THE SAW MILL AND MACHINES.

Fig. 2 shows the exterior of the saw mill, which is 90 ft. by 45 ft., roofed with corrugated iron, supported on masonry walls and pillars, and open nearly all round. It contains the following machines: The Pelton wheel, which is described below; a double horizontal saw frame; a 24 in. pendulum or swing cross-cut saw; a saw sharpener for frame and circular saws; a circular saw with wooden frame and travelling carriage, and 48 in. saws; a circular saw bench for saws up to 24 in.;

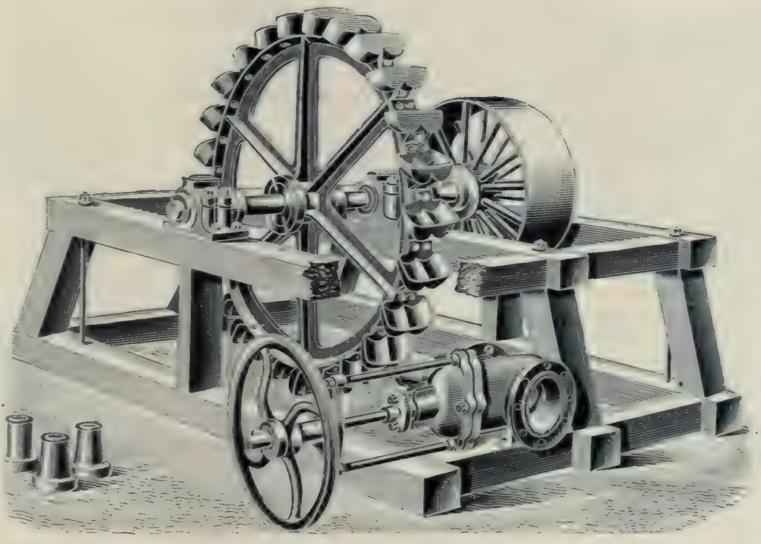


FIG. 3. PELTON WHEEL WITH PLAIN SLUICE VALVE.

a double acting horizontal pump; a 2-ton crane; an overhead 1-ton travelling block for raising logs.

With the above combination of machines, logs of 24 ft. length and 30 in. face can be worked into scantlings of any size.

The horizontal saw (fig. 1), is used for the conversion of rough logs into boards and planks up to 7 in. thickness. The logs are firmly fixed to a cast-iron carriage, which travels automatically at slow speed. The machine works with two saws at once, mounted on separate frames driven from a two-throw crank, having opposite centres. The motion of one saw thus balances the other in equilibrium, and allows of a high speed with little vibration and wear and tear. The hardest woods are cut easily, leaving a surface as even almost as if it had been planed. This machine requires little power, less than 10 b.h.p., and can be worked with ease and rapid change of cut.

Fig. 5 illustrates the swing cross-cut saw, which calls for no explanation.

The saw sharpener is shown in fig. 6, which explains itself. The sharpening is done by means of emery wheels, with excellent results. These three machines are by T. Robinson and Sons, of Rochdale.

THE PELTON WHEEL.

Fig. 3 shows a Pelton wheel. This is a development of the old Hurdy-gurdy wheel, with flat wooden floats, which was common in America and some European countries years ago.

The name is derived from that of an American, who, some twenty years ago, devised a bucket with a backward curve and central division or splitter, which, entering the sphere of the jet, causes the water to divide and flow round the curve of the bucket, and to leave it in an opposite direction to that of rotation, having given up all its force in propelling the wheel.

The buckets are placed at equal distances round the wheel, with the sides at an angle of 75°, which enables the water to escape in a thin stream without striking the following bucket. Different forms of bucket have been tried at different times, in order to overcome the objection to the bucket, when entering the range of the water-jet, momentarily deflecting the stream, but the plain bucket shown in the figure has proved to be the best shape, always provided that its front is placed at an angle, and does not come down flat upon the water. The circumferential velocity of the wheel is about half the theoretical velocity of the jet due to the head, the actual velocity being about 85 to 90 per cent. of this in a smooth jet, which gives the best results. The theoretical velocity is $482\sqrt{\text{head}}$ in feet per minute.

Pelton wheels are adapted to falls from 50 ft. upwards; they can be used for lower falls, but become large, and are less efficient, and more costly, than turbines would be. For high falls no better machines exist, and they can be used with enormously high ones. For example, a 24 in. wheel is in use on the London pumping mains, which, with a jet of only 3-16th diameter, works under a pressure of 900 lb. to the square inch, equivalent to a head of 2,100 ft. Pelton wheels are not affected by the quality of the water working them, and there is no immediate contact with the working parts, as in a turbine. They are

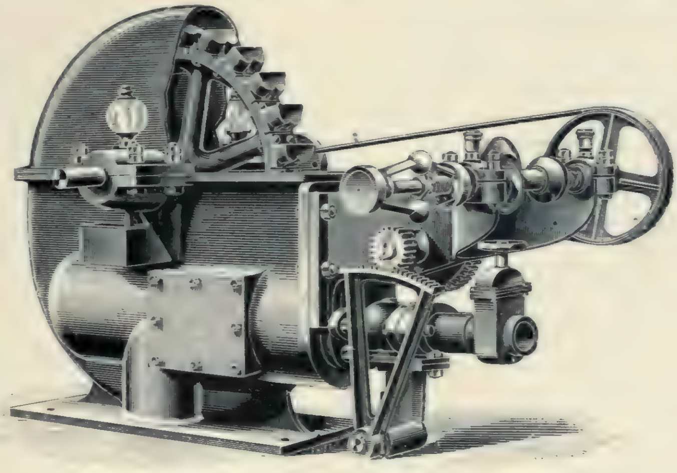


FIG. 4. PELTON WHEEL IN IRON CASING, FITTED WITH GOVERNOR.

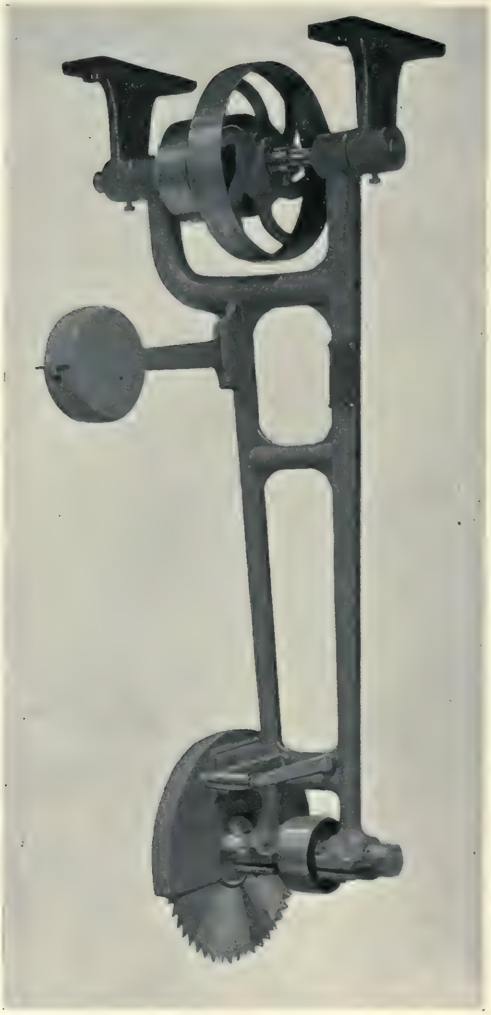


FIG. 5. SWING CROSSCUT SAW.

extremely durable, and are especially adapted to localities where repairs in complicated machinery are difficult and costly to effect, for, even if the buckets, the only vulnerable parts of the machine, get broken or wear out, through the action of sand in the water, they can easily be renewed. These considerations led to the selection of the Pelton wheel as the most suitable machine for working the Mount Stuart Saw Mill.

Fig. 3 shows a wheel of the type made for the mill by Messrs. Carrick and Ritchie, of the Waverley Works, Edinburgh. This wheel has been working most satisfactorily for several years, and no repairs have ever been necessary. It is of cast iron, 4 ft. diameter, with a rim of 4 in. width, turned on the face and truly balanced. There are twenty-four cast iron buckets, 8¼ in. wide, bolted to, and projecting 5½ in. from, the rim. The shaft is 3⅜ in. diameter, supported by three gun-metal bearings, fitted in cast iron blocks. The wheel is mounted on a strong teak-wood frame, made locally.

After leaving the wheel the water falls into a trough, and flows through a built channel, under the floor of the mill. Very little water is carried round the wheel by the centrifugal force, and to prevent splashing the sides of the frame are closed in, and a semi-circular wooden cover is fitted over the wheel, which can be lifted off when necessary.

The nozzle is 2⅞ in. diameter, and is capable of passing about 200 cubic feet of water per minute, under a head of 125·64 ft., giving out about 30 b.h.p. The shaft is fitted with a 36 in. driving pulley making about 225 revolutions. The nozzle piece is screwed on to a strong casting, bolted firmly to the wheel frame, so as to resist the reaction of the water issuing from the nozzle with a velocity of about 4,500 ft. a minute. The water can be entirely cut off by a plain sluice valve, fitted to the main pipe, close to the wheel, similar in construction to that shown in the illustration. This is closed when work stops, and the hand wheel is chained up, as a precautionary measure. The nozzle is fitted with a rod, passing through its centre, with a spear-head shaped end, which can be withdrawn from, or screwed forward into, the cavity, as more or less power is required.

Fig. 3 does not illustrate this method of meeting variation of load, which was designed by Messrs. Carrick and Ritchie. It is the best possible device, as, while the effective area of, and the quantity of water flowing through, the nozzle are reduced, the pressure remains the same. It is to be preferred to that of increasing the power by means of two or more nozzles, which can be raised to play upon different buckets, or deflected to allow the water to run waste, or that of varying it, by means of nozzles of different sizes, which have to be attached, as required, or that of decreasing it by throttling the water by a valve, and thus reducing the pressure. The area of the nozzle is sufficient to pass the maximum quantity of water given above, but it is found in practice that this quantity is never required. The flow can be regulated instantly to meet the demand by turning the hand wheel attached to the rod, and while the Pelton is always working under a full head great economy of water is effected.

It might be presumed that in screwing the displacer back against the pressure, much effort would be required, but this is by no means the case, and the power can be easily and rapidly increased. With a full head the pressure is 54¾ lb. to the square inch. A pressure gauge is attached to the pipe, and is a necessity. A relief gauge is also in use, and a valve for regulating the supply of water to the pump tank.

THE STAFF AND LABOUR SUPPLY.

The carriage of such heavy and unwieldy loads into the heart of the forest was beset with difficulties, which would have been largely increased without the tramway line running from the head of the Ghaut Road, and the trained elephants. The services of expert fitters in such a locality were also of course, hard to get.

The staff now consists of a supervisor and four fitters, two of whom are Malabar natives. A number of coolies have also to be employed daily in shifting logs and sawn timber, and doing jobs connected with the working of the machines and sluices. These men, who belong to a local aboriginal tribe, display considerable intelligence and aptitude, and there has never been an accident in the mill.

OUTPUT OF THE MILL.

About five or six logs, or 250 to 300 cubic feet could be passed daily through the horizontal, but, allowing for loss of time in conversion into sizes on other machines, the actual output does not exceed 100 to 150 cubic feet a day, or about 20,000 to 25,000 cubic feet for the season. There is, of course, a loss of about 30 per cent. of unsaleable wastage, but the selling price per cubic foot of the sawn wood brought to market is more than double that of timber in log.

THE WATER SUPPLY.

The hill occupied by the staff, known as Mount Stuart, to commemorate the visit of a former Governor of Madras, is 450 ft. above the saw mill site. The water requirements of the camp are met by a small double acting horizontal pump, made by Messrs. Hayward, Tyler and Co., of Luton, which delivers the water, drawn direct from the Pelton pipe-line, through a 1½ in. rising main into a large tank at the top of the hill, at the rate of one hundred gallons per hour.

PRECAUTIONS AGAINST INJURY.

The fears that were entertained of injury to the main sluice and wing walls, the channel and even to the mill at night by wild elephants, have proved to be groundless, and the stockade that was constructed round the mill has been removed. The risk of injury to the mill site from floods, which was once very threatening, has since been met by cutting away the bank opposite to the mill considerably, and widening and straightening the waterway.

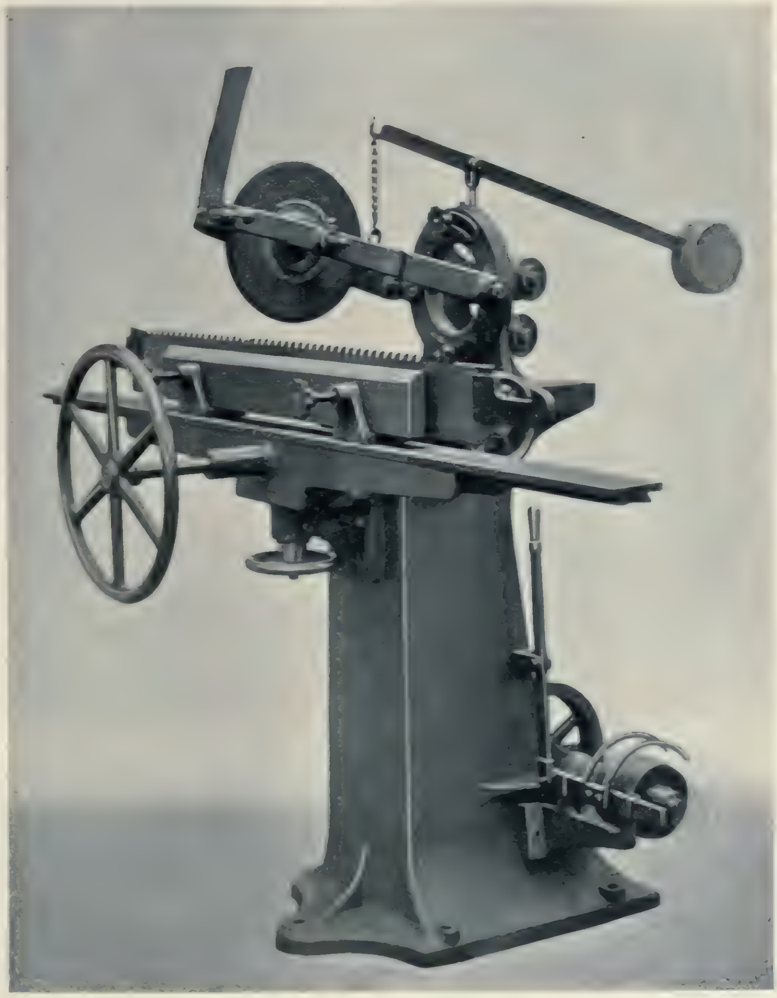


FIG. 6. SAW SHARPENER.

Pelton wheels can be obtained self-contained in an iron casing in a specially portable form, and fitted with a governor to regulate the speed, as shown in fig. 4. They can be adapted to working the heaviest machinery and the lightest loads, such as driving ventilating fans, punkahs, and even dentists' drills, and could be usefully employed in many private houses, where a suitable fall of water is available, for such domestic purposes as working an ice-machine, pumping water, and electric lighting.

NOTES ON THE WESTPHALIAN COAL FIELD.

BY

DAVID A. LOUIS, F.I.C., M.I.M.E., M.A.I.M.E., F.C.S.

In the previous articles, the author dealt with the various methods of working the coal and the systems of transport and winding employed.—Ed.

III.

WATER.

THE field is a very wet one, and 678 gallons of water, or over 3 tons, have to be raised to every ton of coal. The wettest mines are Gneisenau, Courl, and Erin, with a yield of 3,521, 2,432, and 2,421 gallons per minute, respectively. Dams are largely used in the district, and since the introduction of underground pumps, sumps are made of sufficient capacity to hold 24 to 48 hours' drainage; they are placed only from $9\frac{3}{4}$ ft. to $16\frac{1}{4}$ ft. below the lowest level, so as to avoid too great a lift for the pumps. In fact, if by chance the force pumps are fixed at a higher level, auxiliary pumps are employed to lift water from the sump to the higher level. In 1900 there were 51 geared single-acting pumps, 49 direct single-acting pumps, and 40 Woolf pumping engines, all on the surface. The largest Woolf engines had cylinders with $70\frac{4}{5}$ in. and $94\frac{2}{5}$ in. diameter, and 110-in. and 177-in. stroke.

The Gneisenau hydraulic pump is already well known. Underground pumps have only been slowly adopted owing to the fear of their being drowned; to the objection of taking steam underground, and to the loss of steam pressure by condensation; but these prejudices have been overcome, and the use of underground pumps is becoming quite general. Horizontal fly-wheel engines, with plungers connected directly to the piston-rods, are the particular fancy of Westphalia. There were scarcely any geared pumps underground, but all varieties of the favourite type were in use at the time of the writer's visit.

The engines were single, twin-compound, tandem-compound, and twin-tandem compound, all provided with condensers. The pumps were single-acting, double-acting and differential. A fine and remarkable specimen of the twin-tandem compound condensing engine built by Haniel and Lueg, of Düsseldorf, is located 1,640 ft. underground in Gneisenau Colliery. It has triple expansions in four cylinders, and is employed for the drainage of that mine and its neighbours, Courl and Scharnhorst. The lifting capacity is 5,580 gallons per minute, representing about 2,800 h.p. in water lifted, or 3,400 to 3,500 i.h.p. The chief dimensions of this engine are: high-pressure cylinder, $37\frac{2}{5}$ in. diameter; intermediate cylinder, 49 in.; the two low-pressure cylinders each 65 in.; the pump plunger, $11\frac{1}{5}$ in.; stroke, $66\frac{9}{10}$ in. A remarkable feature of this engine is its extraordinary length, the distance from the barring engine at the edge of the fly-wheel end to the centre of the suction pipes in the shaft is about 110 ft. the greatest width, however, is about 25 ft. This peculiar arrangement had to be adopted to suit the breadth of an engine room restricted to $26\frac{1}{4}$ ft. Each pair of cylinders is arranged symmetrically and coupled at right angles to the fly-wheel, which is 21 ft. 8 in. in diameter, and has a tooth rim and a small barring engine for starting. Each side has a double-acting forcing set formed of two single-acting plunger pumps placed back to back, coupled by outside rods and a box condenser and air pump all in one line, the air pumps doing duty as suction lifts in the shaft. The length of the line of rod from the crosshead slipper at the fly-wheel end to the end of the air pump plunger is about 75 ft. All the cylinders and covers are jacketed, the steam admission valves are placed on the tops, and those for exhaust on one side of the cylinders. The high pressure admission valves are fitted with Wiegleb trip gear, and are under control of a governor allowing a variation of 30 to 35 per cent. in the number of revolutions while running. The normal working rate is 60 revolutions, and the piston speed then is 670 ft. per minute. The other admission valves and the exhaust valves are worked by eccentrics from a shaft running parallel to the centre line of the cylinders, receiving motion from the fly-wheel shaft by screw and worm-wheel gearing. This remarkable engine, when working with a boiler pressure of 180 lb., and 165 lb. at the high-pressure admission valve, should consume 11·13 lb. of steam per horse-power in water lifted. It is illustrated in fig. 16. All the larger parts of this engine have been made in sections to enable them to pass down the shaft.

There were in use in 1900, 157 underground fly-wheel engines, 72 underground steam pumps without fly-wheel, and a good few hydraulic pumps utilising the pressure in rising mains. The Kaselowski system being particularly in vogue and doing good work; at König Ludwig mine, lifting 1,540 gallons from 1,722 ft.; at Graf Bismark, 440 gallons from 2,048 ft.; at Hansa, 550 gallons from 2,308 ft.; whilst at Rhein-Elbe No. III. there is a beautiful Kaselowski engine, one of the many fine engine sin the magnificent engine house, raising 440 gallons from a depth of 2,543 ft., and does it with fascinating smoothness, whilst a similar one lifts 3,080 gallons from 1,300 ft. at Altendorf. There are other makers of useful hydraulic pumps. The Kaselowski installation at Rhein-Elbe III. may be selected to illustrate the character of such pumping plants in Westphalia. It was constructed by Maschinenbau A. G. vorm L. Schwarzkopff, Berlin, and its capacity is 70⅔ cubic feet of water per minute from a depth of 2,543 ft., with steam at 120 lb. admission pressure. The plant includes a horizontal twin-tandem engine without condenser, with cylinders 21⅔ in. and 33½ in. diameter by 39⅓-in. stroke, and with 120 lb. of steam, and 60 revolutions a minute, it gives 530 i.h.p. To this are directly connected two double-acting plunger force pumps, with plungers 2¾ in. in diameter by 39⅓-in. stroke; these pumps force the water required to work the pumps into an air pressure accumulator under 250 atmospheres pressure. The accumulator is loaded by means of air compressed to 50 atmospheres by a vertical Kaselowski steam air compressing pump; there are two underground plants associated with this surface installation; one at 2,210-ft. level, to deal with the drainage of the new colliery Rhein-Elbe III., the other at the 1,510-ft. level, to deal with the drainage from the old collieries on the same concession. The former of these is a hydraulic-driven horizontal twin pump, with a working plunger 4⅘ in. in diameter, and a 7-in. forcing plunger, with a common stroke of 23⅔ in., and can lift 70⅔ cubic feet a minute 2,543 ft. when making 30 strokes. The other pump is a vertical hydraulic twin pump, having working plunger 4⅗ in., and forcing plunger 9¼ in. diameter, 19⅔ in. stroke, and when making 25 strokes a minute can lift 70⅔ cubic feet 1,510 ft. These pumps work alternately, so that the same rising main and pressure pipes serve for both. The advantages of hydraulic worked pumps are well appreciated in Westphalia.

Electric pumps are also in use, and there are quick running pumps in some of the mines even to deal with 11,000 gallons from a depth of 1,574 ft. In 1900 there were no less than 422 pumping plants, with a total capacity of 308,000 gallons per minute, capable of dealing with more than four times the in-flowing water.

(*To be continued.*)

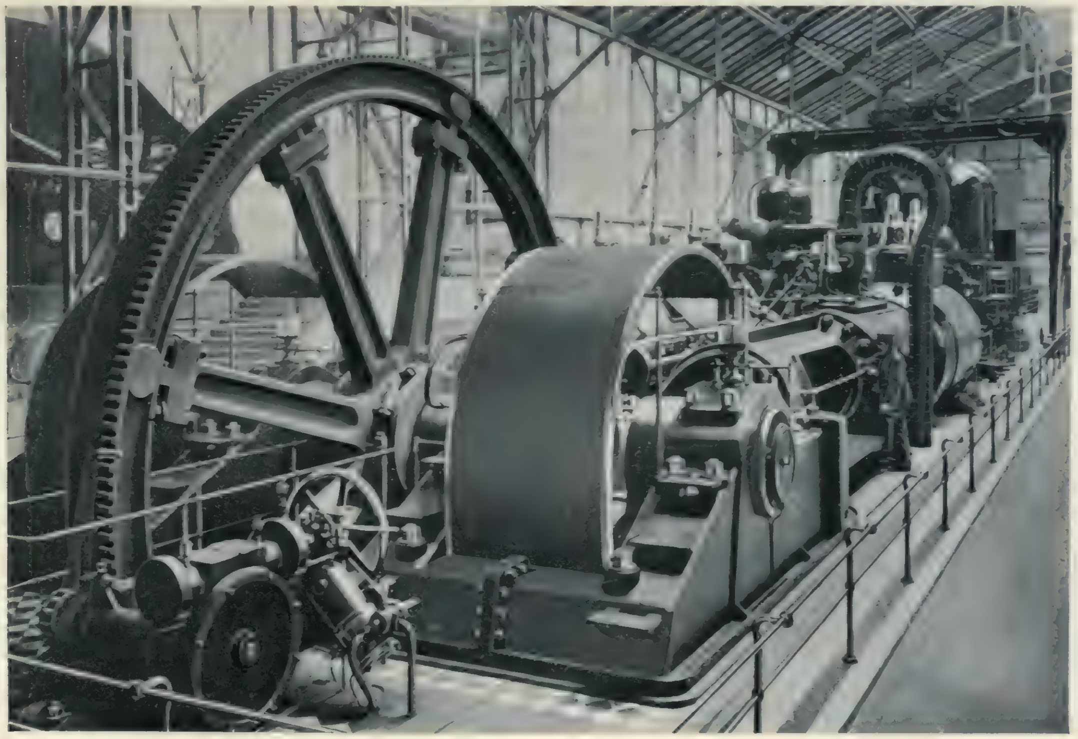


FIG. 16. TRIPLE EXPANSION CONDENSING PUMPING ENGINE, GNEISENAU COLLIERY.
Raising 5,580 gallons a minute from a depth of 1,640 feet.

The Preservation and Protection of Shipping.

THE NEW LIZARD LIGHT.

A CHANGE of considerable importance has lately been made at the Lizard.

Double fixed lights have been shown at this point for more than one hundred and fifty years, and for a quarter of a century two electric lights of about 500,000 candle-power have been employed. The authorities of Trinity House, however, have decided upon a concentration of forces, and an optical apparatus, rendering the Lizard Light probably the most powerful in the world, has been designed by Mr. T. Matthews, M.Inst.C.E., their engineer-in-chief.

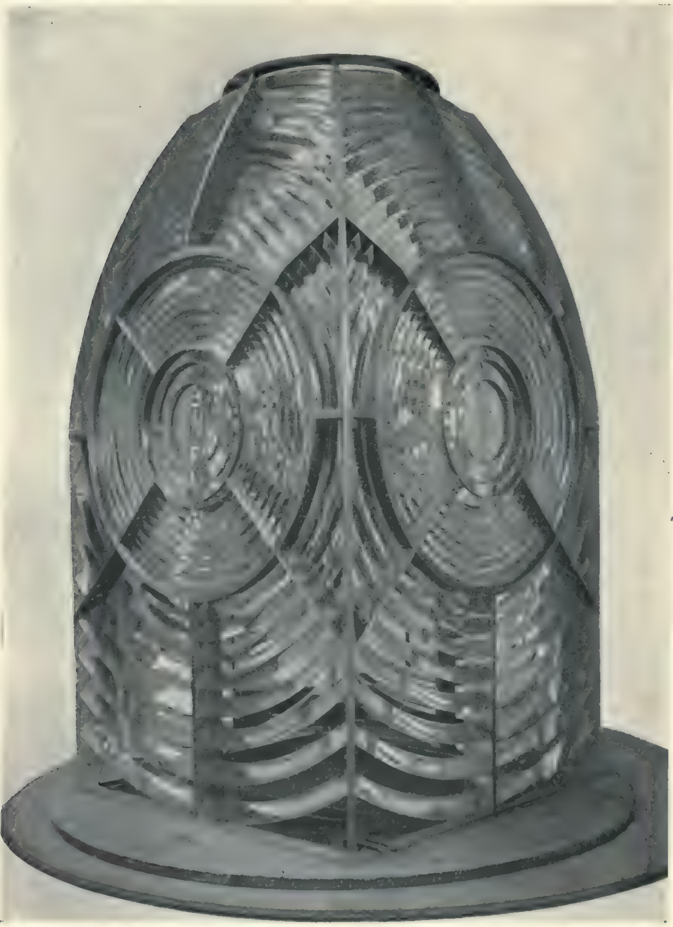


FIG. I. OPTICAL APPARATUS MADE BY MESSRS. CHANCE BROTHERS AND CO., LTD., FOR THE NEW LIZARD INSTALLATION.

Henceforth there will be only one light at the Lizard instead of two, and efforts have been made to render it as characteristic as possible, so as to afford an additional protection against the dreaded "Manacles," and the outlying dangers of the Lizard. A powerful flash is shown every five seconds, and will be seen at a greater distance through hazy weather than was before possible, while it is also probable that in fine weather the light will cause reflections in the sky which will indicate its presence before the lighthouse is in sight.

The electric installation already in use has worked so satisfactorily that it has been found unnecessary to replace it.

For the accompanying illustration we are indebted to Messrs. Chance Bros. and Co., Ltd., of Birmingham, who carried out the designs. Fig. 1 shows the optical apparatus as installed, while the second illustration is included to show the mechanism of the rotating apparatus employed.

The alterations have entailed an expenditure of over £3,000, but under the new arrangement a smaller staff will be required.

ICE BREAKERS AND THEIR SERVICES.

The Institute of Marine Engineers, at one of its recent meetings, had under consideration the important subject of icebreakers, a lecture with the above title being delivered by Mr. R. Gulston. Icebreakers of many forms and dimensions were described, varying from a steam launch 40 feet long, to the enormous

Ermak of 8,000 tons displacement and 10,000 horse power.

Discussing the design of icebreakers, the lecturer remarked that these vessels should have the bow angles and lines so arranged that when they had mounted the ice, and the ice was giving way under the vessel's weight they must not jamb when returning to be water-borne forward, always remembering that they were advancing and should remount the ice. When the ice was broken down it should pass along below the vessel or under the field ice, otherwise it lay on the water and had a tendency to jamb the vessel sideways, which resulted in the icebreaker having to smash a larger proportion of ice than was necessary, to give side clearance, thus absorbing more power, coal and time, and probably resulting in having to back and charge the ice. An icebreaker should also be able easily to turn out of the channel she had cut, and the form of the bow lines had much effect on that manœuvre.

The designs of icebreakers varied so much that there was no certain data to guide builders, but practice had shown that the full forward form, or spoon-shaped bow, was not successful in hard and packed ice, as the vessel pushed the ice in front of herself, instead of cutting and dispersing it. It should be borne in mind that icebreakers, when "charging" in heavy ice, were in collision, so to speak, during the whole time that they were at work, and that entailed much more strengthening of the bows and sides as the ice to be dealt with became more formidable. The shell plating must be considerably increased in small boats, and still more so as the vessels increased in size. Additional stringers, stronger decks, and a liberal addition to the number of bulkheads, transverse and longitudinal, as well as many pillars, became a necessity to prevent the constant recurrence of repairs.

All piping should be kept under the deck, and the fire pipes should be fitted with hydrants below and above that deck. The boiler-rooms must be well closed up, and consideration had to be given to the disposal of the ashes. The rudder should be arranged for easy unshipment afloat, and should be of large area and immensely strong. The moving parts of the machinery and the shafts must be extra strong and largely in excess of ordinary practice. On the engines it was preferable to have direct steam reversing gear, as the "all-round" type was a very heavy tax on the engineers when the ship was icebreaking.

The vessel should be so designed that, if possible, she could be tipped to replace a propeller blade whilst afloat. The captain or icemaster had to exercise considerable care when cutting out vessels fast in the ice, and the procedure was to pass across the bow and then the stern of the fastened ship. Endeavours should be made to crack the ice in some direction towards the ends of the vessel before

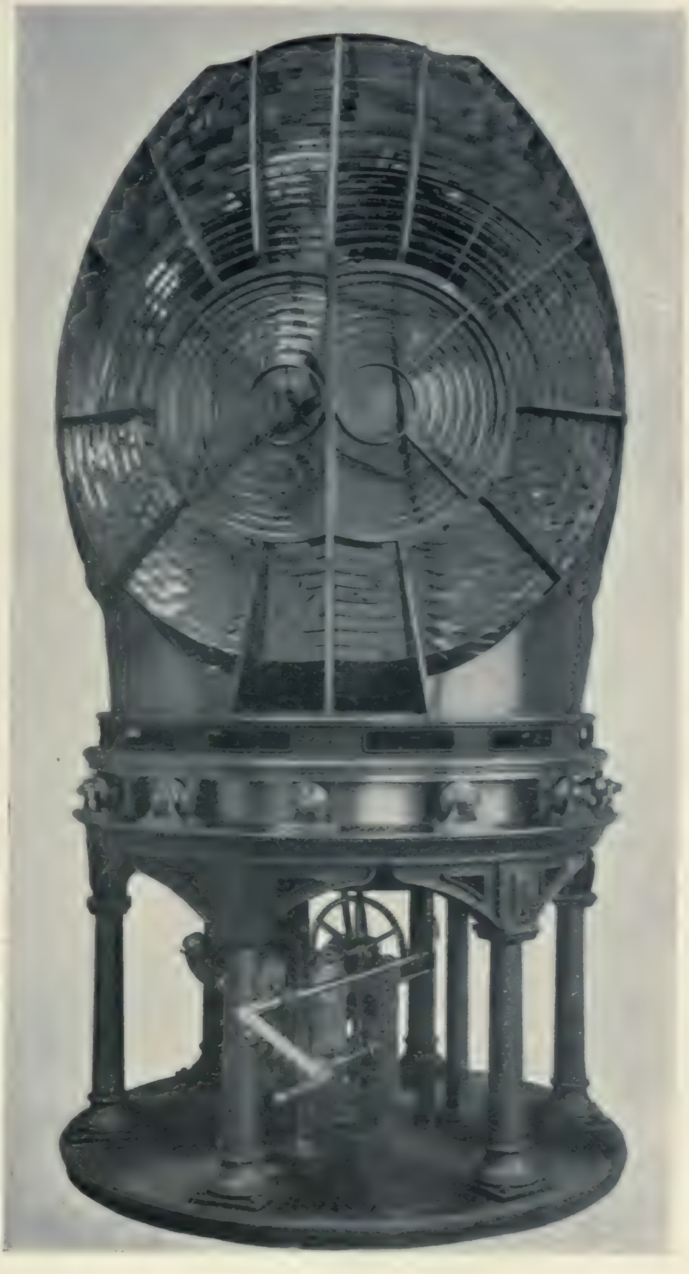
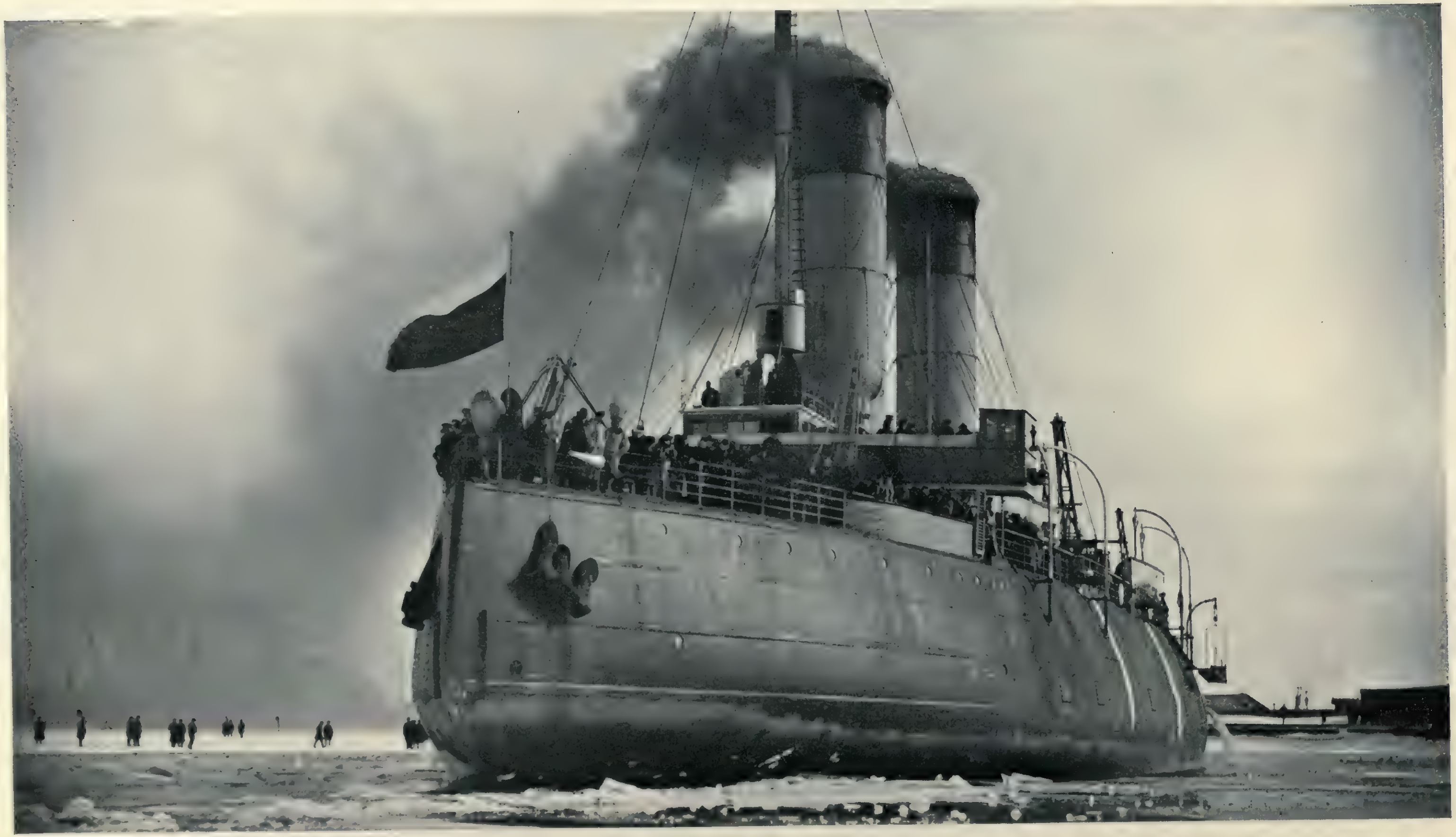


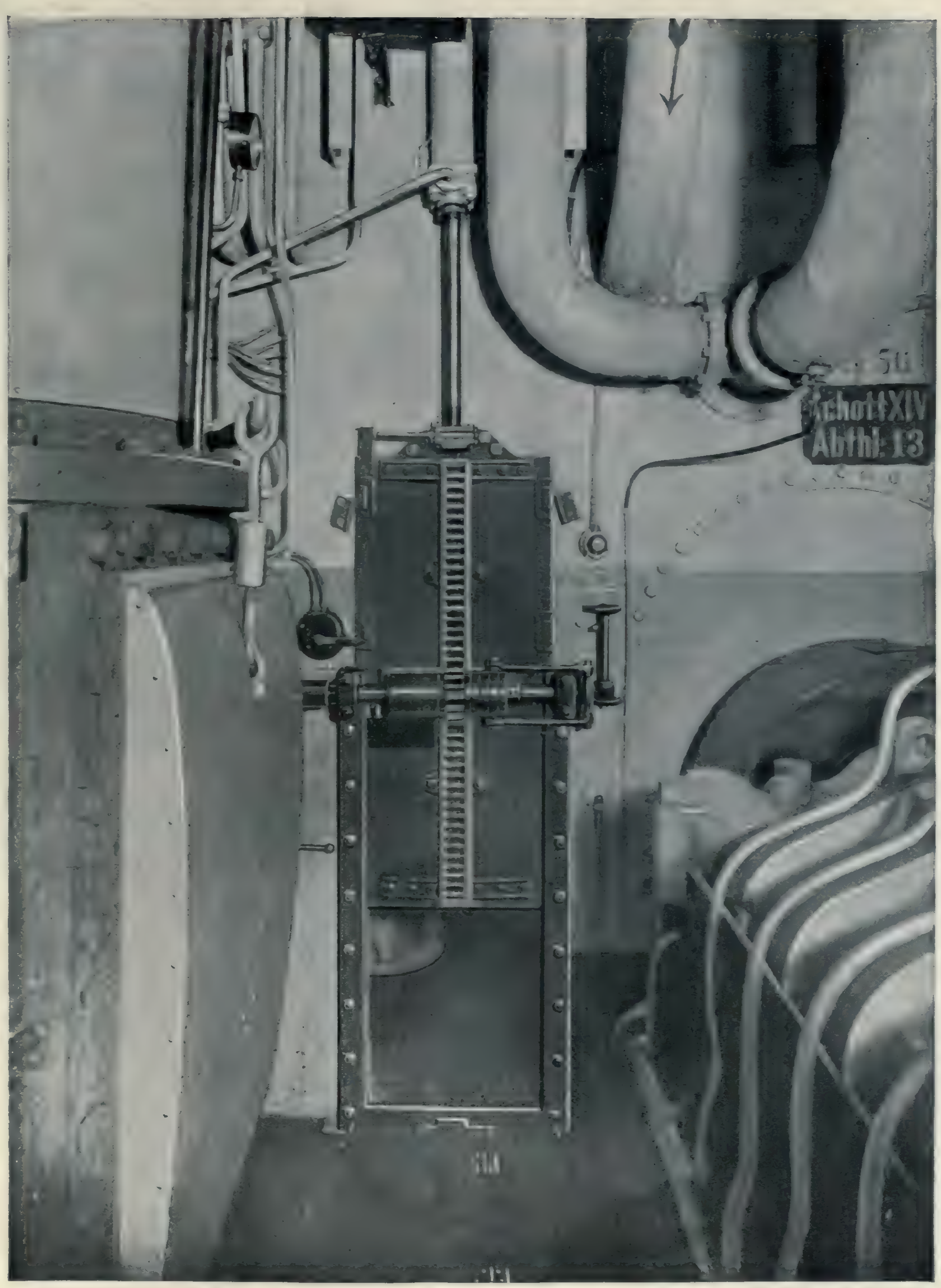
FIG. 2. APPARATUS IN USE AT BEACHY HEAD LIGHTHOUSE.

The rotating apparatus is almost identical with that employed at the Lizard Lighthouse.



By the courtesy of the "United Service Gazette."

THE RUSSIAN ICE-BREAKER "ERMAK" FORCING HER WAY THROUGH THE ICE IN KRONSTADT HARBOUR.



VERTICAL SLIDING WATER-TIGHT DOOR ON THE STONE-LLOYD SYSTEM.

As fitted in the Imperial Mail Steamer "Kaiser Wilhelm II."

passing her in a parallel direction, so as to obviate, as far as possible, all chances of crushing the steamer's sides.

Among other vessels described by Mr. Gulston was the famous icebreaker Baikal, running on Lake Baikal, in the centre of Siberia. That vessel, he remarked, was built to connect the eastern and western ends of the Siberian Railway, which, as they knew, made a continuous railway from Ostend to Vladivostock in Eastern Siberia and Port Arthur in Manchuria. The distance of the ferry across the lake was 52 miles. The Baikal was built on the Tyne. The hull was completely erected, marked, taken down and shipped inside of six months, and 2,700 tons weight in 6,900 packages had to be transhipped across Siberia by boat to the place of re-erection. The boilers, of which there were 15, had to be kept under 20 tons in weight for transhipment purposes, and even those great pieces were moved in sledges by the aid of hand and pony power from the railway trucks to the ship. During the winter that enormous steamer had been at work she had proved herself to be most successful in keeping the service open under difficulties of ice navigation that were unknown, and therefore even unthought of, during her construction. There was, of course, no knowledge of the ice, as regards navigating purposes, on Lake Baikal until that vessel went to work.

The next vessel to be considered was the *Ermak*, built for Polar enterprise, as well as for icebreaking in the Baltic. The speed of the *Ermak* through 24 inches of solid ice, with 6 to 12 inches of snow on it, was 9 knots an hour, and she could charge and demolish packs of ice 20 to 35 feet thick. In Polar ice the speed had to be kept at about from 2½ to 3½ knots per hour, as one was apt to lose control of the vessel in that enormous ice, and the local shocks became very severe when she was charging about at her own "sweet will" amongst the Palæocristic ices. She had proved herself to be of enormous use on her station on the Baltic coast of Russia, where she could negotiate any ice and could safely bring out of danger all steamers that she went to assist. Indeed, in one season she rescued and assisted shipping of over £2,000,000 value, and in another winter she salved the Russian battleship Grand Admiral Apraxine, of £750,000 value.

With the *Ermak* in the Baltic there was no difficulty in Russia putting her fleet to sea, which usually wintered at Kronstadt, as the *Ermak* could easily guide them to open water should the necessity arise, and there was nothing to prevent that vessel herself being made into an armed cruiser.

WATERTIGHT BULKHEAD DOORS IN SHIPS.

The equipment of the German liner *Deutschland* with a complete system of watertight bulkhead doors on the Stone-Lloyd system, calls attention to an important development designed to render ships practically unsinkable.

In the event of a collision or other accident causing an inrush of water, it is, of course, a *sine qua non* that bulkhead doors should be capable of instant closing.

Past failures of bulkhead doors have arisen, in almost every case, from the length of time required to effect the closing at the critical moment. Hitherto the doors have had to be closed individually and mostly by hand. In cases where they were controlled by mechanism, the incompleteness of this mechanism caused the firemen and others working below the water-line, through dread of being shut up in a flooded compartment, or maimed by the unexpected descent of a water-tight door, to prop the doors open with wedges, thus rendering them useless in an emergency. The new system alters all this. The watertight compartments of the *Deutschland* have no less than twenty-four watertight doors, which are worked simultaneously from the bridge. A few seconds after the operation has been signalled by a warning bell, the whole of the doors can be lowered by the officer in charge. At the same time a mechanism is provided by which anyone imprisoned in one of the compartments is able to raise the door temporarily for his escape by lifting a lever. It then closes automatically. Should the officer fail to close the bulkheads it is claimed that any inrush of water would automatically effect the closing of the doors in the compartment or compartments affected; also that in the event of accident to the mechanism of the system itself, all the doors would close automatically.

As fitted in the Norddeutscher Lloyd's mail steamer *Kaiser Wilhelm II.*, and illustrated on the previous page, the installation consists of a hydraulic pressure main running the whole length of the ship, the pressure in which is maintained by means of an accumulator charged with compressed air and water by pressure pumps, one of which pumps air, and the other water, drawn from a tank, into which the exhaust from all door cylinders is connected. The pump, tank, and accumulator are placed above the water line, thus ensuring the closing of the doors, even should the compartment containing the pump, etc., be flooded. Instead of an accumulator, pressure may be taken from another source, such as from the feed pumps. The accumulator supplies pressure, by means of a main, to the bridge, from where it is diverted by means of a fourway cock into two other mains, used respectively for opening and closing all doors, by operating the valves accordingly, and supplying pressure to the hydraulic cylinders. An exhaust main is connected to all the hydraulic cylinders, and discharges into the tank from which the pressure pump supplies itself.

The working of the system from the bridge is effected by means of a small dial with two handles, one for closing and one for opening the bulkhead doors. The handle effecting the closing of the doors from the bridge is secured by a small wheel, which must be unscrewed before the handle can be moved. This proceeding occupies twenty seconds, and sets a warning electric gong ringing over every door. Immediately the handle is released it is moved to the left, by means of which pressure is put on the main, reversing the controlling valves and admitting pressure into the cylinders operating the doors.

SOME MODERN FIRE APPLIANCES.

BY

GEORGE ARMISTEAD.

The previous articles dealt with the work of the Fire Prevention Committee, and the principal English made fire appliances, as well as some important foreign engines and fire escapes shown at the Earl's Court Exhibition.—Ed.

III.

FIRE CALL SYSTEMS.

In group 3—Fire Calls—the gold medals fell to the General Electric Company, Ltd., the National Telephone Company, Ltd., the Siemens Electrical Appliances Company, Ltd., and Messrs. Siemens and Halske, Berlin.

The exhibits of the General Electric Company, Ltd., included apparatus of British design and manufacture throughout.

Their "Annunciator" switchboard in fig. 1, is specially constructed for installation in central fire stations. Among its principal advantages may be mentioned a discriminating buzzer for the purpose of distinguishing between real and accidental calls; it is also fitted with a complete set of telephone apparatus enabling the station to call up any office or department. All the parts are accessible for examination when required.

A watchroom type of switchboard has been constructed by the Company to the latest London County Council specification. This apparatus, intended for fixing in fire station watchrooms, is provided with an "on" and "off" switch, push button, and name plate for each fireman, and by arrangement of the connections it admits of the whole staff being called out or only individual members.

For street use a post is provided, as shown on page 158. This consists of a locking pull to be operated by

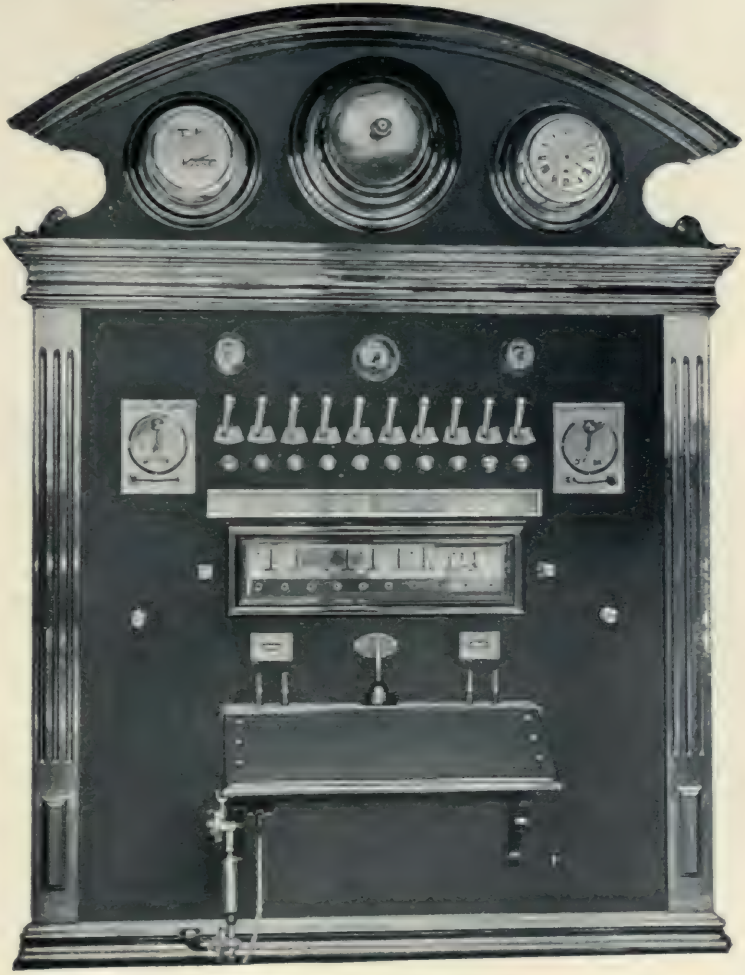
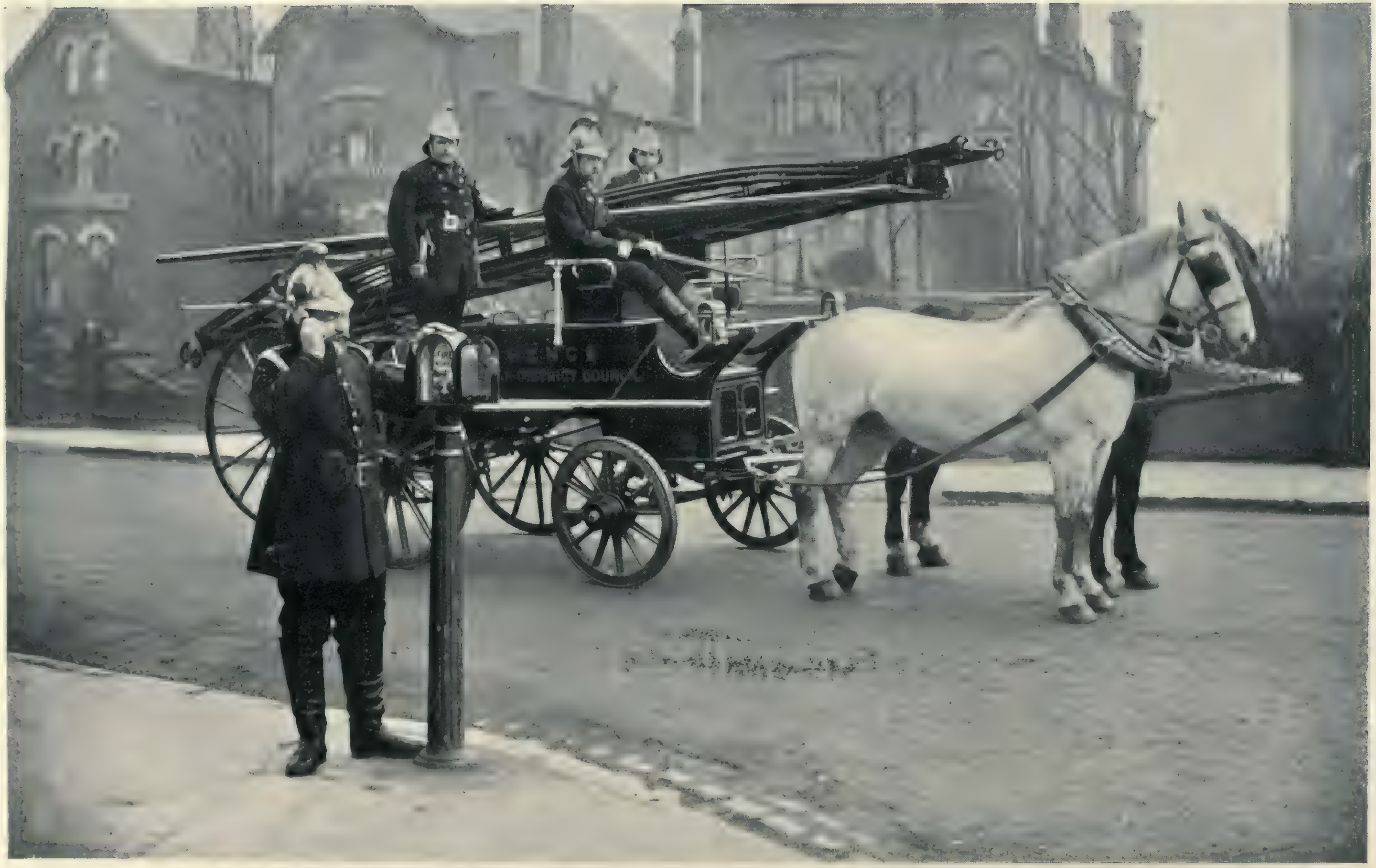


FIG. 1. THE "ANNUNCIATOR" SWITCHBOARD OF THE GENERAL ELECTRIC COMPANY, LTD.



THE GENERAL ELECTRIC COMPANY'S FIRE CALL SYSTEM AT WORK.

the public, and also a complete telephone set communicating with the station, so that the Brigade can at once proceed to the fire without losing time in calling at the point of alarm for instructions.

Another post of somewhat similar type is fitted with plug holes for plugging a portable telephone set, to be used only by the fireman or policeman on duty. This portable telephone apparatus is illustrated in fig. 2. It is of the collapsible type, and is carried by the fireman on his belt. This type of post can be seen in working order at Tottenham, Finchley, Penge, etc.

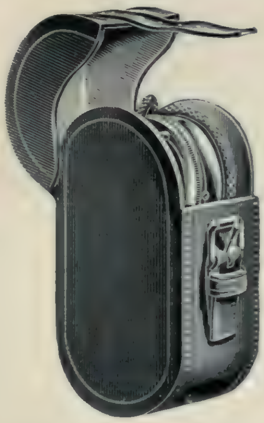


FIG. 2. PORTABLE TELEPHONE APPARATUS BY THE GENERAL ELECTRIC COMPANY, LTD.

An ingenious fire and police alarm system which has been established at Liverpool, was exhibited by the National Telephone Company, Ltd., who were awarded a gold medal for their exhibit. Under this system street alarm boxes are fixed (to sides of buildings, or other suitable places) in all the important parts of the city, and connected with the nearest district police office. From each of these boxes six automatic alarm signals (having any meaning which may be desired) can be sent; for instance, "Patrol Wagon," "Horse Ambulance," "Fire," "Serious Fire," "Patrol Waggon B" (for cases where a number of constables are required), and "Telephone," together with the number of the box from which the call, or alarm is sent. These signals are recorded at the district police office by means of dashes and spaces, printed upon the tape of a recording instrument similar in design to an ordinary Morse telegraph inker. In each box there is a visual indicator to notify the person sending the alarm that the call has been received. This indicator is also used (by reversing the colour from red to white) to attract the attention of the constable on the particular beat in which

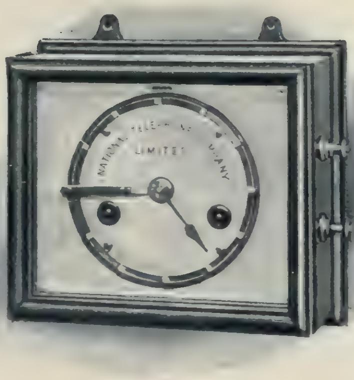


FIG 3.

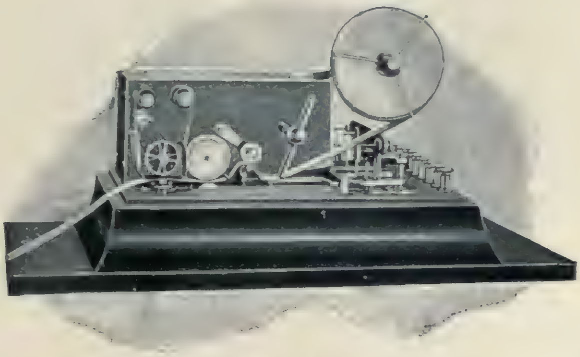


FIG. 4.

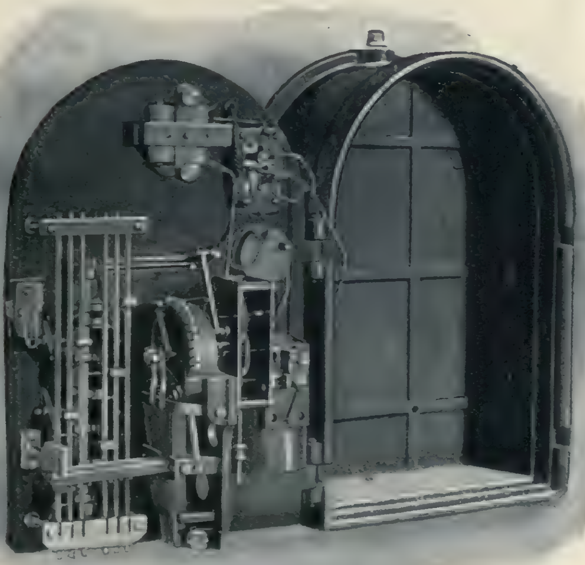


FIG. 5.

Clock (fig. 3), Morse Inker (fig. 4), and Alarm Box (fig. 5), used in the National Telephone Company's system.

the box is situated. He can then communicate with his district office through the telephone fitted in the box.

There is also an arrangement by which the constables can report themselves to the district police office from the different boxes they pass upon their beats. This is accomplished by means of a special report key, which, when placed in the key-hole at the bottom of the box, and turned once round, causes the number of the key used, together with the number of the box, to be printed on the tape of the recording instrument, also the time at which the signal is given.

Before an alarm can be sent the door of the box must be opened; this is done with a key of ordinary pattern, but which, when turned in the lock, cannot be withdrawn until released by a master key. The object of this is so that the person giving the alarm can be traced if necessary, the key being stamped with a number, and a record kept to whom it was issued. Inside the box are the six handles, or levers, each clearly marked. To send an alarm the handle marked with the signal required must be pulled down. This sets the mechanism of the box in motion, and causes the required signal and box number to be printed on the tape of the recording instrument at the district police office, also the time at which the signal is given. (See figures 3, 4 and 5.)

The alarm box, fig. 5, comprises cast-iron box fitted with mechanism, six transmitting levers and and a telephone set. The station outfit comprises a Morse telegraph inker with time stamp, and a clock. (Figs. 3 and 4.) The inker acts as a receiver, the dashes sent by the transmitter being recorded on a tape.

TWO NOTABLE FIRE ALARMS.

Another prominent feature was the Pearson Fire Alarm System, which, by the way, has recently been installed at the Mansion House. Under this system it is necessary in protecting a building to provide a number of automatic points, or thermostats, which are fixed upon or around the ceiling, each thermostat covering a superficial area up to 400 square feet. For this purpose the well-known "Schoppe" thermostat is employed, the company having secured the sole rights in this invention for the United Kingdom and the Colonies. A pair of wires running throughout the building connect up the different thermostats with the automatic transmitter, which is placed at or near the street entrance of the building. A main circuit connects the transmitter with the central office or fire brigade station. An accidental breakage of the wire is recorded by a special signal, so that the system not only guards the building in which it is installed, but also automatically guards its own efficiency.

The Siemens Electric Appliances, Ltd., were also awarded a gold medal for their Automatic Fire Alarm System. The action of their automatic alarm depends upon the expansion of a liquid in a thermometer shaped tube, which, at a pre-arranged temperature, bursts the glass bulb. Their alarm, which is designed for both open and closed circuit working, is enclosed in a perforated metal cap and may be fixed in any convenient spot.

In the automatic alarm designed for open circuit working, the glass tube in its normal position keeps a spring from touching a lower contact, but as soon as the bulb bursts, the spring is released, the circuit closed, and one or more alarm bells actuated.

In the automatic alarm suitable for closed circuit working, on the other hand, the bulb of the glass tube presses two springs together, so that a current is always flowing through the circuit. With the bursting of the glass bulb, the main circuit is broken, and an alarm given on one or more bells.

It is claimed for the closed circuit that it is superior to the open circuit system, in so far as a constant control is kept over the whole installation. Indicators are also connected to their system to show in which part of the building an alarm has been given.

FIG. 6. CUTTING UP JARRAH FOR SLEEPERS.

MATERIALS OF CONSTRUCTION.

This subject is one upon which volumes might be written. There can be no question but that the section of the Exhibition in which were shown so many samples of material designed to render outbreaks of fire presented an invaluable object lesson. Gold medals in the class for building construction were awarded the Columbian Fire-Proofing Company, Ltd., and Millar's Karri and Jarrah Company (1902), Ltd.

The exhibits of the latter company were designed to bring to the notice of engineers and others the suitability of Western Australian Karri (*eucalyptus diversicolor*) and Jarrah (*eucalyptus marginata*) for engineering works, street-paving, and all other purposes where hard wood is required. It is claimed for these woods that they possess the additional merit of comparative non-inflammability, and a section of a Jarrah pile was exhibited, which had been in use for thirty years in Bunbury Harbour, in order to show that it is proof against the ravages of the subaqueous attacks of the teredo or those of the white ant above ground. Other exhibits were designed to show the utility of these woods for railway work, more especially sleepers, timbering shafts, wood-paving, flooring, etc.

Fig. 6 shows the cross-cutting of a huge tree to sleeper length for South African railways. Sleepers of this wood were used for the Severn Tunnel throughout.

ELECTRICAL SAFEGUARDS.

The Simplex Steel Conduit Company exhibited very attractively their fireproof system of conduits and fittings for safety electric wiring, the arrangement admirably illustrating how with a complete system of this kind the whole of an installation may be readily tested and inspected throughout by the removal of inspection covers. The tubes and fittings are, of course, incombustible and fireproof. On a board at the side were shown a sub-station code box and six thermostats connected up by Simplex conduit and fittings, illustrating the special adaptability of this system for electric fire-signal work. The conduits are made for socketed or screwed junctions, and are enamelled or galvanised, the brazed conduits or tubes being used for places where it is necessary that the wires are required to be in a water-tight encasement and watertight fittings in subways and such places where moisture is nearly always present. A switch with new special mounting made by this company is shown herewith, together with an inspection cross-piece. (Figs. 7 and 8.)

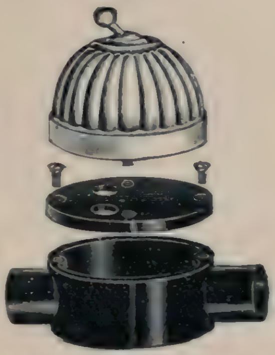


FIG. 7. NEW SWITCH, WITH SPECIAL MOUNTING.

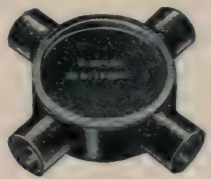


FIG. 8. INSPECTION CROSS-PIECE.

We have only been able to take a cursory glance at a few of the more important exhibits, but enough has been said to indicate the valuable nature of the work done by the International Fire Prevention Congress, and the Exhibition. The question of fire prevention and extinction opens up more problems than at first sight appear. Those who wish to pursue the subject are advised to obtain the official report of the Congress.* It includes many valuable papers by English and foreign experts, edited with conspicuous ability and admirably arranged for reference.

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* "The Official Congress Report," with an Introduction by Edwin O. Sachs. Published for the British Fire Prevention Committee by *The Public Health Engineer*.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel Mining and Allied Industries.

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OUR MONTHLY SUMMARY.

LONDON, January 22nd, 1904.

For Apprentices and Pupils.

A carefully devised scheme has been issued by the Educational Committee of the North-East Coast Institution of Engineers and Shipbuilders, comprising regulations for apprentices and pupils which it is hoped may be generally adopted. By way of an immediate inducement for youths to voluntarily undertake "the severe discipline, self-denial, and hard mental work entailed by systematic study" in the higher branches of their profession, the scheme attaches increased pay to certain educational qualifications. Times have changed. The pursuit of knowledge had its own reward for some of us, but in these days students must have everything made easy for them, and we must also give them monetary inducements to go in and win. At the same time the principle of "payment by results" is involved in this scheme, and while it will materially help the industrious, it will automatically point out triflers.

Do We Work Hard Enough?

This is a question which is borne in upon us after a perusal of the clever series of articles lately concluded in the *Times* on the Industrial Conditions in Germany. Germany's success in commerce may be summed up in the one word—"work." A singularly solid and stable edifice has been built up by work—not in one or two directions, or by one or two classes, but work all round and from top to bottom, from the Kaiser to the workshop apprentice. The Government has always kept in view the duty of fostering industries, and the manufacturers have pushed resolutely forward, point by point, taking advantage of everything that might help them. The workmen have a less easy time than English workmen, and more to pay for a good living, but as regards actual well-being, the *Times'* commissioner has no hesitation in saying that in the mass they are better off. The difference is due partly to the habits of the people and partly to the institutions for preventing destitution, among which the Poor Law system and the State insurance are the most important. Do *we* work hard enough? It is a pointed question, and one which would seem to call for a great social preacher who would talk common sense to our working men, and make them realise that the individual makes the State, and that each owes it to the State to do his full share in the work of the world.

The New Year.

Turning from the shortcomings suggested by these articles, and putting aside the ever-present doldrums associated with our national drink bill, we can turn with relief to the expansion of our foreign trade. While stump orators are trying to persuade us that the British Empire is practically moribund, out come the Board of Trade Returns. There is no hysterical shrieking or playing of brass bands. John Bull, informed that the "foreigner" has "grabbed his trade," calmly produces a blue book, makes no comment, and leaves the man in the street to judge for himself. It is shown that during last year the value of the goods imported amounted to £542,906,325, as against £528,391,274, an increase of £14,515,051, or 2·7 per cent. of produce, and of manufactures exported during that period the value was £290,890,281, an increase over 1902 of £7,466,315, or 2·6 per cent. The exports of foreign and Colonial merchandise have also increased £3,742,222 to £69,557,035, making the aggregate value of the foreign trade of the country £902,853,641. Surely this will serve to discount some of the pessimistic utterances of the time, and admit a cheerful anticipation of our operations in the New Year.

Belfast Shipbuilding.

Our congratulations are offered to Messrs. Harland and Wolff on their record year, an account of which will be found elsewhere. It is interesting to note that the increase in the output of the engine works has kept pace with that in the shipbuilding yard, the grand total being 100,400 i.h.p. This includes the engines for the battleship *King Edward VII*. The previous year's figures (which included the engines of H.M.S. *Queen*) showed a total of 60,200 i.h.p. Last year, therefore, gives an increase of 40,200 h.p., or 66 per cent. over 1902. Messrs. Harland and Wolff have shown themselves such adepts at beating their own records, that we shall look forward to their next year's record with a lively interest. A statement has been published to the effect that the firm have already received an order for a vessel exceeding the *Baltic* in size, but it has received official contradiction.

The Second Mosely Commission.

We are now awaiting with interest the report of the Mosely Commissioners. Mr. Mosely recently gave the following account of the American tour to an interviewer: We spent ten days in New York, and then visited Washington, where President Roosevelt gave us a reception and a most excellent speech; Hampton coloured schools, Baltimore, Philadelphia, New Haven, Niagara, Chicago, and Indianapolis, where our party split up. Some went further west to California, while a considerable portion, including myself, worked back east to New York, visiting Dayton and Pittsburg, Ohio, on the way. At every town committees met the delegates at the stations, formed them into groups, and conducted them to the various educational institutions. As a consequence they saw the maximum of work with a minimum of exertion and waste of time. Without anticipating the report of the delegates, I think I may say that they have brought home vast stores of knowledge as to what is moving the United States in its upward movement of industrial prosperity, and that educationally they have accumulated a vast amount of knowledge, which should be of great interest to the nation.

Mr. Wicksteed on Thorough Draughtsmanship.

The President of the Institution of Mechanical Engineers, whose article on the Evolution of the Chain appears in another part of the magazine, is a great believer in thorough draughtsmen. On a recent occasion he remarked that draughtsmanship was the A B C of mechanical engineering. He knew of many draughtsmen trained in Leeds who had gone to Russia, to France, and the United States, where they were getting 50 per cent. higher salaries than professors in shops where at least half a dozen professors were engaged. If men could afford to give their sons a four years' course at a university, by all means let them do so, but let that course be followed by at least a two years' course in draughtsmanship. If that were done, the student would be a better draughtsman, but the man who spent four years learning mechanical draughtsmanship would be a better man than he who had only spent four years studying at college.

The Chicago Fire.

Although the terrible theatre fire at Chicago has been shown to have arisen through a falling spark from a movable electric arc lamp, it by no means follows that the holocaust can be laid to the charge of electricity. Indeed, the application of the electric luminant has unquestionably minimised the risk of fires in theatres. A fireproof curtain that failed to act and exits that refused to open were chiefly at fault, and the whole sad affair should bring home to some of our London managers the fact that too much attention cannot be given to the comparatively small details that go to make up safety. Little things are often sufficient to cause great conflagrations. The fire at Exeter Theatre in the Jubilee year, when two hundred people perished, is a case in point. A broken window caused a current of air, which brought a portion of the scenery into contact with an insufficiently protected gas jet. The place was very soon a roaring furnace, and in twenty minutes the roof fell in. The loss of life was largely owing to inadequate exits, and this is where we think attention might with advantage be given in some of our London theatres.

The Late Sir William Allan, M.P.

A man of striking personality and character has been lost to the engineering world in the person of Sir William Allan. His views on the boiler question were of a pronounced order, and the fighting instincts which carried him through the American Civil War stood him in good stead in the House of Commons. Self-made and self-reliant, he was emphatically a man to admire. Like so many other hard workers, he found time to give to unexpected pursuits, and there was a poetic side to his nature which rendered him intensely human. A notable saying of the late knight was, that the world had been his chief educator, and men his books.

Is Business System Overdone?

One hears so much about system in these days that it comes almost as a shock to realise that it may be sometimes overdone. Mr. John Calder has been writing in one of the American journals on "The Use and Abuse of System," and there are several rules in regard to office and shop routine which he recommends managers to observe irrespective of the class of work done. They are as follows:—

1. Have a system definite and business-like in all departments.

2. See that a broad view of the subject is taken, and provision made for properly dovetailing the departmental systems.

3. Make the connection clear to all concerned by using graphic charts.

4. Have as *little* system and as few forms as possible. Make them a means, not an end. There are many needless items which are perpetuated, on card indexes and business forms to-day, in some systems.

5. Prune and pare the system till it gives economy, accuracy, and despatch in sales and manufacture.

6. Be always on the outlook for improvements but discriminating in adopting them.

It is emphasised that a system, like the plant itself, is worth no more than it can earn. All money, brain friction, and worry expended beyond this point are thrown away. Dead uniformity and absence of scope for individual initiative are not necessarily factors in securing what are the sole justification for special outlay on system—economy, accuracy, and despatch in sales, manufacturing, shipping, and installation.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT,

BY

N. I. D.

GREAT BRITAIN.

TRIALS of battleships during the past two months have resulted in most cases satisfactorily. The *Queen* early in December last, at an eight hours' full-power trial, attained a speed of 18·4 knots. The revolutions averaged 116·4 starboard and 115·9 port, the gross i.h.p. being 15·556. The coal consumption worked out at 1·76 lb. per unit of power per hour.

In December, too, the *Prince of Wales* underwent a trial at one-fifth power attaining a speed of 10·45 knots, on a coal consumption of 2·2 lb. per unit of power per hour.

The *Hibernia*, which is one of the three battleships of the programme of the current financial year, was commenced at Devonport on January 7th.

In the armoured cruiser class there are several completions to report. The unlucky *Euryalus* has at last been put into commission, and with her the whole of the *Cressy* class of the programme of 1897–98 is completed. The *Euryalus* has gone to the Australian station. The *Monmouth*, of the *Kent* class, was commissioned on December 2nd for the cruiser squadron, the *Berwick* of the same class hoisting the pennant a week later. In November the *Bedford*, for the Channel fleet, and the *Donegal* for the cruiser squadron, were also put into commission.

The trials of the *Cornwall* have not at the time of writing been completed, but her preliminary runs are reported to have given satisfactory results. The eight hours' full-power trial of the *Suffolk* resulted as follows: Mean revolutions—starboard, 138·1, port, 139·3; i.h.p., 22,645; coal consumption, 2·2 lb. per unit of power per hour; speed, 24·7 knots, which is the best recorded speed for any vessel of the class.

The report which gained some publicity last October, to the effect that a new armoured cruiser of the *Duke of Edinburgh* type was to be built at Chatham, was at the time very generally discredited. The officials at the dockyard have now, however, been informed by the Admiralty that such a vessel is to be built there, on the slip which will be vacated by the *Devonshire* during February. No vessel of 480 ft. in length has previously been attempted at Chatham, the 450 ft. of the *Devonshire* having been up to the present as much as the slips there have been able to take. The armoured cruiser *Roxburgh* was launched on January 19th, the Duchess of Montrose performing the naming ceremony.

The *Diamond*, a third class cruiser of the *Amethyst* class, was launched from the works of Messrs. Cammell, Laird and Co., Ltd., of Birkenhead, on January 6th. This is the first vessel to leave the stocks since the amalgamation of the two firms Charles Cammell and Co. and Laird Bros. The *Diamond* is 360 ft. in length, and displaces 3,000 tons. With forced draught it is anticipated that she will develop 9,800 h.p., and attain a speed of 21·75 knots. Her boilers are to be of the modified Yarrow type, and for armament she will carry twelve 4-in. quick-firers and twelve smaller guns.

Contracts for thirteen of the destroyers of the programme 1903–04 have been divided as follows: Messrs. Palmer, at Jarrow, will build three, the *Swale*, *Ure*, and *Wear*, which are each to have four Reed boilers; Messrs. Hawthorn, Leslie and Co. will build three, the *Boyne*, *Doon* and *Kale*, which will have four modified Yarrow boilers each; Messrs. Cammell, Laird and Co. will build three, the *Liffey*, *Moy*, and *Ouse*, each of these being supplied with four Laird's water-tube boilers; Messrs. Yarrow will build two, the *Gala* and the *Garry*, each having four Yarrow boilers; while Messrs. Thornycroft are building the *Chalmer* and the *Colne*. These will each have four Thornycroft-Schultz boilers. Two more, at present unnamed, are, it is understood, to be built by Messrs. J. S. White, of Cowes, and supplied by them with White-Forster boilers.

The official trials of the *Blackwater*, built by Laird Brothers, have been completed. On the full speed trial the vessel maintained a speed for four hours' continuous running of 25·656 knots. She was run in a fully loaded condition. This is the fourth of the new type of destroyers built by Laird's which has completed her official trials, the first three vessels being the *Itchen*, *Arun*, and *Foyle*.

FRANCE.

Progress in the French Navy has not been very marked in the past two months. The event of the greatest importance was, of course, the launch of the battleship *Patrie* at La Seyne on December 17th. A vessel launched is not, of course, a vessel completed, especially in the French Navy, but it is at least a sign of progress, and as such is to be welcomed. The *Patrie* is of the *Republique* class, 439 ft. in length, 79½ ft. beam, and 27½ ft. draught. She displaces 14,927 tons, and is designed to attain a speed of 18 knots, with engines developing 17,475 h.p. It does not appear to have been yet decided as to what boilers she shall be provided with, both Belleville and Niclausse having been mentioned in this connection.

The boilers for the armoured cruiser *Jules Michelet* appear to have been decided upon, a modification of the grating surface in the Guyot boilers of the du Temple type having been approved by the Minister of Marine. The boilers will be twenty in number.

The *Marseillaise* has been commissioned for service in the Northern Squadron.

The *Admiral Aube* has finished all her official trials. On a run at full power of eight hours' duration, made at Cherbourg on December 17th, the indicated horse power developed was 22,155, or 1,655 above what was required of her, with a speed of 21·9 knots. The coal consumption per indicated horse power per hour was 1·83 lb. at the rate of 34·3 lb. per square foot of grate area. The working of the engines and of the boilers of the Belleville type, with economisers, fitted on board of this ship, is reported to have been perfect.

The *France Militaire* states that the French Minister of Marine intends that experiments shall be carried out on the turrets of the new armoured French cruisers, *Gloire* and *Condé*, similar to those to which the fore turret of the *Suffren* was subjected a short time ago. On the occasion of these new experiments officers will take their place within the turrets in order to observe and report upon the shock effects produced when the turrets are struck by the shells fired upon them. It is known from experiments on shore that the shells, under the conditions imposed, will not be able to pierce through the armour of the turrets. Officers volunteered, but were not allowed to be within the fore turret of the *Suffren* when it was fired upon by the guns of the *Massena*. The *Gloire* and *Condé* are still at Lorient, where they were built, and where the *Gloire* has recently been undergoing her trials.

Two submarines, the *Ludion* and the *Estingeon*, were launched on January 7th and 9th respectively.

GERMANY.

Of the £5,160,000 for non-recurring expenses in the German Navy Budget for 1904, £3,385,000 is for shipbuilding, and includes the following items: A fourth and last instalment of £113,000 each for the battleships *Braunschweig* and *Elsass*, third instalment of £223,300 each for the battleships *Preussen* and *Hessen*, third and last instalment of £264,000 for the large cruiser *Roon*, third and last instalment of £52,300 each for the small cruisers *Hamburg*, *Bremen*, and *Berlin*, third and last instalment of £26,400 for reconstruction of battleships of the *Brandenburg* class, second instalment of £312,000 each for the battleships "M" and "N," second instalment of £241,000 for the large cruiser *Ersatz Deutschland*, second instalment of £116,850 each for the small cruisers "M" and *Ersatz Merkur*, second and last instalment of £72,000 for reconstruction of the large cruiser *Kaiserin Augusta*, and of £57,500 for reconstruction of the small cruiser *Irene*, first instalment of £124,750 each for the battleships "O" and "P," first instalment of £58,800 each for the small cruisers "N," *Ersatz Alexandrine*, and *Meteor*, first instalment of £38,400 for the gunboat "C," second and last instalment of £118,600 for a torpedo-boat division, and first instalment of £148,800 for a second torpedo-boat division.

Not a little satisfaction has been felt and expressed by the German public and the German press at the rapid completion of the second class cruiser *Hamburg*. The keel was laid in August, 1902, and on December 15th, 1903, the vessel was ready for commissioning. On her trials she made 23·3 knots with 11,000 h.p., exceeding the contract speed by 1·3 knots, and the contract power by 1,000.

RUSSIA.

The Franco-Russian works at St. Petersburg have secured the contract for the engines and boilers for the new Russian ironclad *Andreii Pervozvannui*; the boilers, twenty-five in number, are to be of the Belleville type.

According to reports the battleship *Tsarevitch*, on her way out to the Far East, accomplished several excellent steaming performances, and behaved very well in bad weather. Between Singapore and Port Arthur she did not touch at any port, and when eighty miles distant from the latter place, succeeded in getting into communication by wireless telegraphy. Her average speed for the whole journey was 10 knots, and during a continuous run of fourteen hours' duration she maintained a speed of 18·94 knots.

It is announced that the Ministry of Marine has under consideration plans for a new type of armoured cruiser, possibly that to which the three vessels of this year's programme are to belong. The displacement is stated to be 16,000 tons, and the speed 22 knots. The proposed distribution of the armament is noteworthy. All the 6-in. and 8-in. guns will be placed in ten armoured turrets, and the armour protected side will be very extensive. The vessels of this type are intended for service in the Far East.

Five new torpedo destroyers, to be named respectively *Grozni*, *Jivoy*, *Jivontchy*, *Jontky*, and *Jark* have been laid down, and are to be hurried forward with all despatch.

UNITED STATES.

The trials of the *Maine* in November last were interesting, mainly because of the discussion on the merits and demerits of the Niclausse boilers with which that vessel is fitted. The *Maine* has twenty-four boilers grouped in three eights, having a grate surface of 1,353½ ft. and 53,343 square feet, of heating surface. Her engines are supposed to develop 17,348 h.p. On the trial no attempt was made to force the fires, and the committee, which was present during the trial to observe the results, reports that forced draught is unnecessary and undesirable, and should never be used for boilers of the class. The boilers gave no trouble, no difficulty was found in reaching 115 revolutions with the main engines, and there was a quick response to varying demands for speed. The coal used was 1,474 tons, and the average rate of combustion per square foot for the run north was 16·45 lb., and the average coal per indicated horse-power 2·45 lb. This was not satisfactory, but too many boilers had been lighted for the number of revolutions. The Committee insists very forcibly upon the importance of providing fresh water for all types of water-tube boilers, and is of opinion that the entire arrangements of the distilling plant and of the feed pumps must be altered if water-tube boilers of any design are to be a success. Evaporators should not be crowded into places so hot that men cannot give them the attention they demand. The boilers of the *Maine* are fine examples of mechanical work, and will require the services of men of intelligence and mechanical skill. The committee insist that the quality of the *personnel* is of greater importance than the quantity, and that water-tube boilers call for more brain work and less physical effort. Automatic feed devices were in use, but the Board says they cannot be trusted.

As a result of this trial it is announced that the Navy Board have decided to keep to the Niclausse boilers originally designed for the battleships *Virginia* and *Georgia*, and the armoured cruisers *Pennsylvania* and *Colorado*.

Bids have been solicited by the Navy Department for the construction of two 13,000-ton battleships, the *Mississipi* and *Idaho*. The maximum time allowed for the completion of the vessels is forty-two months. I have already given the main features of these vessels in these notes, and it is unnecessary to repeat them. The engines will be of the vertical twin-screw three-cylinder triple expansion type, fed with steam by eight water-tube boilers of a type yet to be decided upon.

Locomotive Engineering Notes.

BY

CHARLES ROUS-MARTEN.

Compound Locomotives.

Extreme as has been the slowness with which the compound principle as applied to locomotives has come into use in Britain since its modern initiation by Mr. F. W. Webb in 1882, there, at last, are symptoms—if one may judge from appearances—that the principle is to receive a more extended trial henceforth than it has hitherto enjoyed. So far, it must be admitted that the London and North-Western Railway and its late chief mechanical engineer have enjoyed an honourable, if regrettable, solitude as regards the compound crusade. Mr. Webb built his first compound locomotive some twenty-two years ago, completed at a cost not far short of £100,000, a first batch numbering thirty of the same type and class which, as express engines, have hardly been a success; and then constructed four successive batches of forty, ten, ten, and ten of express locomotives on the same principle, but of different dimensions, all having three cylinders —the first three of these batches proving distinctly efficient and useful. He also built a number of eight-coupled goods engines to his three-cylinder compound design. Then he suddenly and absolutely abandoned that design, and brought out instead a four-cylinder system, differing in virtually every main respect from its predecessor. It is now represented by eighty large express engines and a number of eight-coupled goods locomotives. That practically sums up the history of locomotive compounding on the only British railway that has systematically carried it out during a long term of years. The various sporadic experiments on the London and North-Western Railway with different types of compound tank engines may be neglected as not germane to the real inwardness of the present subject. At the present moment there has been reached, through the retirement of Mr. Webb and the appointment of his successor, a break in the continuity of the compound chain. That is to say, it is not yet known authoritatively outside the secret places of the Crewe offices whether the London and North-Western express locomotive, at any rate of the future, is to be compound or non-compound, and, if the former, whether of the four-cylinder or the three-cylinder type.

The London and North-Western "Alfreds."

It may reasonably be questioned whether Mr. Webb's final type of express compounding has even yet undergone a really fair test in actual service. The twenty engines which comprise that class, viz., No. 1941 "Alfred the Great," and nineteen others numbered consecutively up to 1980, were still in course of construction when the Traffic Department issued the much-discussed order that every London and North-Western express should be piloted if its load exceeded "17 coaches," reckoned on the basis of a twelve-wheeler representing 2 coaches, an eight-wheeler, 1½, and a six-wheeler or four-wheeler 1 "coach," and that this rule should operate irrespective of gradients, speeds, or other conditions. Now, an average 17-coach train on the London and North-Western Railway may be taken as weighing about 300 tons empty, or 305 to 320 tons including passengers, staff, luggage, and stores. I made a number of trials with these engines, and found them quite able to keep time with "17 coaches" even at fast bookings, but, of course, I had no chance of seeing what they could do with heavier loads in the ordinary service. Nor has it been possible to infer from their performances in association with a pilot engine what they could have done unassisted. *Prima facie*, it is difficult to understand why these more powerful four-cylinder compounds of the "Alfred" class should be deemed incapable of doing what a less powerful three-cylinder compound, *e.g.*, "Jeanie Deans," used to accomplish day after day. The heating surface of the newer type, 1,557 square feet, was manifestly too small to keep two 16-in. high-pressure cylinders adequately supplied with "live" steam at 200 lb. pressure. But, on the other hand, shortness of steam did not appear to be exceptionally common in their case.

New Valve Gear.

Assuming the Traffic Department's order for piloting with loads greater than 300 tons behind the tender to be justified by any ascertained shortcomings on the part of the new locomotives—which I distinctly do not assert as the result of my own experience—the question would naturally arise whether these elaborate and costly and fine-looking machines could not by some re-arrangement of design, be made more efficient. With this view, Mr. George Whale, the new chief mechanical engineer of the London and North-Western Railway, has devised a new duplex valve-gear, which is said to be giving results enormously superior to those obtained with the original gear. The special advantage of the new valve-gear is that it enables the cut-off to be varied at pleasure in each cylinder independently of the other. The ability thus to employ an independent and different cut-off when this should seem advisable has always been recognised as one of the most valuable features of the de Glehn system of compounding. Mr. Whale employs only one reversing screw with which both the high-pressure and low-pressure valve-gears can be worked either together or separately, the variation being effected by means of simple mechanical modifications. The engine selected for experiment with the new valve-gear is No. 1952 "Benbow," one of the "Alfred" class. This particular engine had earned a certain amount of celebrity by the efficiency and regularity with which she ran the fast dining express to and from Birmingham, allowed 125 minutes for the 113 miles each way. On one occasion while fitted with the ordinary valve-gear, she made the up journey in exactly 121 minutes under my own observation, hauling a load reckoned as fourteen coaches. It will thus be seen that even with the original valve-gear, "Benbow" acquitted herself creditably, although of course neither was the load really heavy nor the speed specially high. But during experiments which were officially made between Crewe and Stafford in each direction with the new valve-gear, the superiority of her working was remarkable. For example, taking unaided a train weighing 372 tons behind the tender, "Benbow" ran from the Crewe start to the Whitmore Summit, 10½ miles, in 18½ minutes, averaging 34 miles an hour, and reaching a maximum speed of 40, whereas with her original valve-gear, the 10½ miles occupied 22 minutes, averaging 28·6 miles an hour, and the highest speed she could attain up the bank was 34. The work in the opposite direction is less noteworthy because the so-called "bank" is so very easy that it would ordinarily be regarded as almost a level stretch, the greater portion being no steeper than 1 in 2,105 to 1 in 505, while only for three miles immediately preceding the summit is it so steep as 1 in 391 and 1 in 398. Here, also, however, the better results of the new valve-gear made themselves prominent, the average uphill speed being 43 miles an hour, and the maximum 52, as against 37·3 and 45 with the old gear. Moreover, the maximum indicated horse-power, which was 814 one way and 756 the other with the old gear, was 940 and 949 respectively with the new. These figures speak for themselves, and afford reason to hope that with the aid of the new valve-gear these fine-looking engines may ere long be able to prove unwarrantable the reproach that they are unable to do without assistance the work for which they were specially designed and built.

The Tri-Cylinder Midland Compounds.

At present it certainly would appear that the tri-cylinder express compounds designed and built by Mr. Johnson on Smith's system for the Midland Railway are likely to prove a permanent institution. Whatever theoretical objections may be taken to the employment of three cylinders instead of four, it would be unpractical and unscientific also to allow undue weight to these in the face of the results of actual experience. It is undeniable that much of the disadvantage attaching to the use of only three cylinders is materially mitigated when the driving-wheels are coupled, while it is accentuated when the different pairs of driving wheels are worked independently. How far the success of the Midland compounds may be due to the fact that London and North-Western practice is reversed in another particular, namely, the use of one instead of two high-pressure cylinders and of two instead of one low-pressure, is a question upon which much diversity of opinion exists, and upon which a great deal may be said both *pro* and *contra* each method. What seems to me more to the point, in the view of the results attained, is the relative proportion adopted between the cubical capacities of the high-pressure and low-pressure cylinders. In Mr. Johnson's engine the single high-pressure cylinder is 19 in. in diameter. That is equivalent, roughly, in cubical capacity to two separate cylinders each 13½ in. in diameter. In Mr. Webb's engines there are two high-pressure cylinders, each 16 in. in diameter, and two low-pressure 20½-in., while Mr. Webb provides a boiler having 1,557 square feet of heating surface against Mr. Johnson's 1,598 square feet. Thus, Mr. Webb provides somewhat less boiler power with considerably more high-pressure cylinder capacity. It may be observed that Mr. Johnson's cylinder ratios approximate those with which M. de Glehn has achieved such remarkable success. And when we come to the practical outcome we find that, whereas in the London and North-Western case it has been deemed necessary to adopt certain stringent limitations of load in consequence of complaints made of unpunctuality, in the other two cases we see the engine successfully taking loads hitherto unheard of as worked by one engine at anything like such high-booked speeds, and doing so with a degree of success that appears absolutely without qualification. It is legitimate to hope that as altered by Mr. Whale, the North-Western compounds may yet give full satisfaction. Meanwhile, Mr. Johnson may be congratulated upon the success which has from the first been attained by the engines of his design. The case is purely one of judging a tree by its fruits.

The North-Eastern Colossus.

The enormous "Atlantic" engine which Mr. Wilson Worsdell has designed and built at Gateshead for the heavy express service of the North Eastern Railway, could not be got ready so soon as was anticipated. Owing to unavoidable delay in obtaining certain necessary materials, her construction was materially retarded, and the engine did not come out until just before the end of the year. The principal dimensions of this vast engine were given in the August issue of PAGE'S MAGAZINE, page 171, and it will doubtless be remembered that they represented an engine far larger and heavier than any other of the four-coupled class hitherto seen in Great Britain. In view of the very fine work performed under my notice by its immediate predecessors, Nos. 2101-2110, of which it is virtually an enlarged development, there seems no reason to doubt that the North Eastern "Atlantic" will afford something like finality in the long effort to secure an engine that will grapple adequately with the latest requirements of the North Eastern's heavy express service. Two or three of the new "Atlantics" are now out and are taking their part very satisfactorily in the ordinary winter express work. This, however, manifestly affords no true test of their capacity, which will not be thoroughly brought to trial until they have to take their part in running the very heavy summer expresses of the coming season. These, even since the introduction of the "2001," "2011," and "2111" classes, have hitherto required the occasional use of an assistant engine, but it may reasonably be hoped that Mr. Worsdell's new colossi will render piloting a mere "memory of the past" on the North Eastern Railway.

SHIPBUILDING NEWS.

BY

"SHIPBUILDER."

IT was predicted here last month that when the shipbuilding returns for 1903 were completed it would be found that the total would probably turn out as much as 200,000 tons short of that of 1902. This, of course, referred to the output of the United Kingdom, which is now seen to have been 1,409,630 tons, as compared with 1,616,235 tons in the previous year—a decrease of no less than 206,605 tons, which is rather greater than our estimate. It is evident that there was even more inactivity in the English yards than was supposed, for the Scotch total (on the returns of the *Glasgow Herald*, whose figures are carefully compiled) was 484,853 tons, as compared with 566,553 tons, a decrease of only 81,700 tons. At the end of November the Scotch record was 85,000 tons short, but there was a considerable output in December to reduce the difference. The output of the British Colonies was 37,225 tons, as against 24,700 tons. In so far as returns have been received from foreign countries, the output of the rest of the world seems to have been 1,232,676 tons, as against 1,074,735 tons in 1902. But we do not present these last figures as conclusive, or as proving an actual increase in the foreign production. The 1902 figures we know to be defective, and those for 1903 we do not recognise as perfect.

World's Output.

The following tabulates the whole world's output of new ships :—

	1903.			1902.	
	Vessels.	Tons.		Vessels.	Tons.
Scotland	362	484,853	...	404	566,553
England	871	766,295	...	937	891,109
Ireland	25	158,482	...	27	158,573
United Kingdom total ...	1,258	1,409,630	...	1,368	1,616,235
Colonies	96	37.225	...	86	24,700
Foreign	1,087	1,232,676	...	939	1,074,735
Grand total ...	2,441	2,679,531	...	2,393	2,715,670

The United Kingdom, it will be seen, has a larger tonnage than all the other countries of the world combined, including even the British Colonies.

I.H.P.

The above includes both sailing ships and steamers, but with regard to the latter the following has been the—

WORLD'S OUTPUT OF MARINE ENGINE POWER.

	1903. i.h.p.		1902. i.h.p.
Scotland	497,396	...	510,808
England	727,221	...	669,368
Ireland	128,450	...	107,100
Total, United Kingdom ...	1,353,067	...	1,287,276
Colonies	12,966	...	10,815
Foreign	986,452	...	719,163
Grand total ...	2,352,485	...	2,017,254

Here, again, the United Kingdom beats the rest of the world.

The Work of the Year.

The actual number of vessels launched all over the world during 1903 was, according to these returns, 2,441, with a tonnage of 2,679,531, and an indicated horse-power of 2,352,485. In 1902 there were returns of 2,393 vessels of 2,715,670 tons and 2,017,254 indicated horse power. The number of vessels in 1903 was thus more by 48, the tonnage less by 36,139 tons, and the indicated horse power greater by 335,231. More than half of the tonnage was produced within the United Kingdom, England turning out 871 vessels, of 766,295 tons; Scotland, 362 vessels, of 484,853 tons; and Ireland, 25 vessels, of 158,482 tons. With the exception of the United States, no foreign country launched an aggregate tonnage equal to the Clyde, viz. :—277 vessels, of 446,869 tons. There was a decrease on the Clyde, the Tay, the Dee, the Tyne, the Wear, Tees and Hartlepools, the Thames, in Ireland, Germany, France, and Holland; and an increase on the Forth, the Mersey, the Humber, the English Channel, in the Colonies, the United States, Russia, Norway and Sweden, Italy, Austria-Hungary, Japan, Denmark, Belgium, and China.

Scotch District.

The following table shows the number, tonnage, and indicated horse power of vessels produced in Scotland during the year. There is a decrease in each section, of 42 vessels, 81,800 tons, and 13,412 i.h.p. :—

	1903.			1902.		
	Vessels.	Tons.	i.h p.	Vessels.	Tons.	i.h.p.
The Clyde	277	446,869	455,221	312	516,077	458,870
The Forth	30	15,356	13,445	38	12,800	12,260
The Tay	19	16,223	19,460	29	24,255	28,800
The Dee	36	6,405	9,300	25	12,431	10,878
Total	362	484.853	407.396	404	566,553	510.808

English Shipbuilding.

And the following tables, compiled from the reports from English shipbuilding districts, show a reduction on the year's output of 65 vessels, 124,814 tons, and an increase in the indicated horse power of 57,853 :—

	1903.			1902.		
	Vessels.	Tons.	i.h.p.	Vessels.	Tons.	i.h.p.
The Tyne	149	262,794	254,405	144	324,487	277,960
The Wear	60	189,339	137,465	67	230,277	159,453
Tees and Hartlepools	67	171,304	89,640	74	192,709	111,600
Mersey to Solway ...	80	55,705	89,401	67	28,502	19,165
The Humber	125	31,065	36,510	120	26,457	24,135
Royal Dockyards ...	4	28,290	1,400	5	51,560	12,500
The Thames	195	18,494	98,916	306	29,104	51,129
English Channel ...	181	8,550	18,554	147	6,950	12,821
Bristol Channel ...	10	754	930	7	1,063	605
Total	871	766,295	727,221	937	891,109	669,368

Irish Shipbuilding.

The following is the Irish record :—

	1903. Tons.	1902. Tons.
Harland and Wolff	110,463	78,959
Workman, Clark, and Co. ...	44,738	75,430
Londonderry Co.	2,188	3,354
Dublin Co.	605	430
Larne Co....	380	400
Palmer, Cork	108	—
	158,482	158,573

The most notable return in the shipbuilding year is that made by Messrs. Harland and Wolff, who have made a tonnage output of over 100,000 gross tons, and 100,000 i.h.p. The position attained by this firm is unique in the annals of shipbuilding. They have again placed in the water a vessel for the White Star Line—the *Baltic*—largest in the world's list of large vessels. This return is noticed elsewhere. The output of this firm for the year consisted of eight enormous vessels, seven of which were full-powered passenger and mail boats, or combined passenger and cargo boats of exceptional size. The eighth was H.M. yacht *Enchantress*—3,540 tons displacement—built entirely to Messrs. Harland and Wolff's own designs.

Largest Builders.

The leading shipbuilders in 1903 were as under' according to their tonnage :—

	Vessels.	Tons.
Harland and Wolff (Belfast)	8	110,463
Swan, Hunter, and Wigham Richardson (Tyne) ...	22	61,589
John Brown and Co., Ltd. (Clyde)	6	55,152
Armstrong, Whitworth, and Co., Ltd. (Tyne) ...	13	48,740
Russell and Co. (Clyde)	13	45,810

In 1902 the order of the first six firms was :—Harland and Wolff ; Workman, Clark and Co.; Swan and Hunter ; Russell and Co. ; Armstrong, Whitworth and Co. ; and Wm. Doxford and Sons.

In marine engineering the leading firms in 1903 were :

	i h.p.
Harland and Wolff	100,000
The North-Eastern Marine Company (two shops)	80,275
John Brown and Co , Ltd.	61,000
Richardsons, Westgarth, and Co. (three shops)...	55,010

In 1902 the North-Eastern Marine Company were first, and were followed in their order by Messrs. Richardsons, Westgarth and Co. ; Messrs. H. and W. Hawthorn, Leslie and Co. ; the Wallsend Slipway Company ; and Messrs. Harland and Wolff.

Foreign Shipbuilding.

The following summary table of foreign shipbuilding returns shows an apparent increase in the number of vessels launched and of indicated horse power produced in foreign countries in 1903, as compared with 1902. The increases are most pronounced in the United States and Russia :—

	1902			1903.		
	Vessels.	Tons.	i.h p.	Vessels.	Tons.	i.h p.
United States ...	188	493,144	324 290	162	325,678	172,528
Germany	271	261,003	197,225	259	260,755	232,287
France	71	107,431	70,107	102	102 300	81,208
Holland	180	71,423	49 233	176	92,067	34,010
Russia	40	63,726	124,163	15	2,743	19,035
Norway and Sweden	94	61,057	45,262	67	42,303	30,954
Italy	62	52,380	24,976	26	50,030	34,426
Austria-Hungary ...	34	37,268	24,515	26	21,233	22,455
Japan	59	35,411	91,996	48	35,032	64,120
Denmark	20	23,840	21,500	20	22,168	14 020
Belgium	18	17,301	7 570	14	15 332	7,195
China	45	6,031	5,085	22	3,824	5,875
Spain	1	2 040	—	1	2,040	—
Greece	4	72	530	1	200	150
	1,087	1,232,676	986,452	939	1,074,735	719,163

In some cases in the above list warships are included, and in other cases are not. The comparison is with a total of 939 vessels, and 1,074,735 tons in 1902, which, however, did not include warships built in Russia, and was otherwise imperfect.

British Comparison.

The principal shipbuilding districts in Britain, grouped along with the leading foreign countries, again show the predominance of the United Kingdom. If steamers only were taken into account the preponderance would be greater still, as much more of the Continental than of the home tonnage is made up of sailing vessels :—

	Vessels.	Tons.	i.h p.
United States	188	493,144	324 290
The Clyde	277	440,809	455,221
The Tyne	149	262,794	254,405
Germany...	271	261,003	197,225
The Wear	60	189,339	137,465
Tees and Hartlepools	67	171,304	89 640

A New Coal Carrier.

Among the notable productions of the year was *Hedwig Heidmann*, built by Sir Raylton Dixon and Co., Ltd., Middlesbrough, for carrying coals from the Scotch collieries, on the Firth of Forth, to Hamburg, and especially adapted for this trade by several peculiarities of construction and outfit. The most remarkable feature is that for size she will carry more water ballast than any other ship afloat, amounting in all to over 1,400 tons. This is carried in such a position that she will be remarkably easy in heavy weather, the propeller being always submerged in either light or loaded trim. The upper structure is so designed that the inner shell plating and frames are carried up to the deck in a diagonal line fore and aft, and a superstructure is built on this containing the water ballast, carried to the side of the vessel, thus making her very strong. In outer appearance and space for discharging cargo and working the ship she is like any ordinary vessel. The cargo holds have been so arranged that they are free from any obstruction, such as beams and pillars. She is designed to discharge a cargo of over 3,000 tons in eight hours. This is the most efficient and economical type of steamer yet built specially adapted for coal, grain, and ore. The net register of such a vessel may be less than one-third of the dead weight—*i.e.*, the ship will carry a 3,200 deadweight cargo of coal on a net register of about 1,000 tons. This constitutes the lowest register of any description of full-decked ship.

Yacht for the Sultan.

From the Elswick shipyard the yacht *Erthogroa*, destined for the Sultan of Turkey, was recently launched. It has a length between perpendiculars of 260 ft., and a displacement of 900 tons.

THE CIVIL ENGINEER AT WORK.

By C. H.

The New Tube.

London's latest tube connects Finsbury Park Station on the Great Northern Railway with Finsbury Pavement in the City, a distance of about 3½ miles, the intermediate stations being Drayton Park, Highbury, Essex Road, and Old Street. The line is for the most part conducted underground in two tubes, the most extraordinary feature of the new line being the increased diameter of the tunnels, which are 16 ft. wide, opening out to nearly 23 ft. in diameter at the stations. This renders possible the admission of ordinary rolling stock. The accompanying illustration, from the *Light Railway and Tramway Journal*, shows the diameter of the tube as compared with those of the Central London, and other railways. Everything is of a larger scale than in the tubes to which we have already become accustomed, and while greater width and ample proportions of the stairs and passages have been ensured, it is anticipated that the new tube will score in the direction of ventilation. In order to minimise the amount of noise and vibration, a vitrified blue brick invert supporting the iron roof has been largely employed. The trains will be equipped with the multiple unit system of the British Thomson-Houston Company, Ltd., which will admit of the trains being operated in either direction from either end. The power is supplied from a single generating station in Poole Street, New North Road, and by this arrangement it will be possible to operate the line without feeding from any other point.

It is proposed to run a three-minute service of seven coach trains, the single journey being completed in about 13½ minutes, including three intermediate stops of twenty seconds each. The trains will be worked on the shuttle principle at the termini, thus avoiding shunting, and it is intended to complete the double journey in thirty minutes. With this service there will be eleven trains running. Each train, which weighs about 200 tons when normally loaded, has a seating capacity of 505 passengers, and is composed of three motor cars and four trailers.

The engineers responsible for the work are Sir Douglas Fox and Mr. Francis Fox. The contractors are Messrs. S. Pearson and Son, the British Thomson-Houston Company, Ltd., being responsible for the electrical equipment, power house, line, and rolling stock.

All structures connected with the tube are fireproof, not excepting even the signalmen's cabins, and the platforms are of solid concrete and iron. Every care has also been taken in dealing with the electrical equipment to make the fireproofing a matter of primary importance, and an independent lighting system is supplied throughout the tunnels.

London has now to look forward to a conversion of the Metropolitan Railway and the completion of the Baker Street and Waterloo, and the Charing Cross and Hampstead Railways.

The Cape to Cairo Railway.

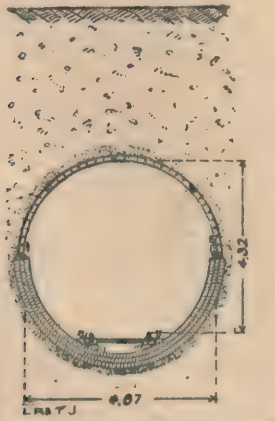
Discussing progress in Africa in 1903, the American *Review of Reviews* remarks that the French engineers are constructing railways and opening trade routes in the African regions under their control. It is to be remarked, moreover, that the French have just completed a railway across their great African island dominion of Madagascar. The Belgians also are doing some remarkable railway building in the Upper Congo country. The British line northward from Bulawayo is already within a few miles of the Zambesi River, which forms the northern boundary of what is known as Rhodesia; and doubtless within a very few years the line will be advanced across British Central Africa to the boundaries of the Congo Free State. Thus Mr. Rhodes' great conception of a connected rail route from Cape Colony to Cairo will in due time be realised

Indian Irrigation.

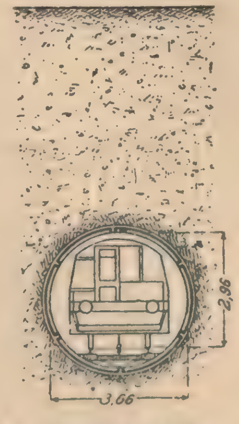
The Indian Navigation Commission report that there is a wide but not unlimited field in which the engineers and civil officers can work together for the protection of the country from famine.; partly by the construction of new State irrigation works, and partly by encouraging and stimulating the extension of irrigation by means of private works. Both methods will involve heavy expenditure on the part of the State, upon which there will be no direct return, although it may be justified by the value of the protection afforded.

The New Dock at Llannelly.

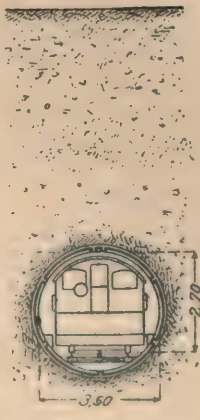
The Llanelly North Dock, which was begun in March, 1898, has now been thrown open. The construction of the dock has occupied about two years. It is nine acres in area and has a depth of 28 ft. The cost was nearly £250,000, the contractor being Mr. L. P. Nott, of Newcastle.



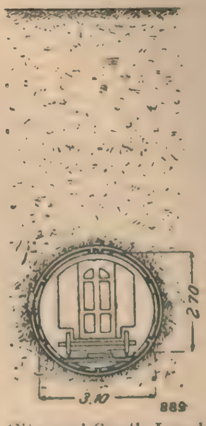
Gt. Northern and City Tube,
3·5 miles, diam. 16 ft.



Waterloo and City,
1·5 miles, diam. 12 ft.



Central London,
6·5 miles, diam. 11 ft. 6 in.



City and South London,
6 miles, diam. 10 ft. 6 in.

POWER STATION NOTES.

By "ELECTRICAL ENGINEER."

The Simplicity of Transmission Plants with Pelton Wheels as Prime Movers.

In the Colonies there are many towns which will some day wake up to the possibility of using the power of a neighbouring fall, for water power is, in a sense, perpetual motion, as its continuous use exhausts none of the resources of nature. Manufacturers would do well, therefore, to lay themselves out to supply the plant at a reasonable price, and of the right kind for the work, for it is good paying business. It is really wonderful how easy to run a three-phase transmission plant may be made, especially when the prime mover is that wonderfully simple and cheap form of apparatus—the Pelton wheel. The writer calls to mind a plant for the East, where the machinery arrived during the wet season, when the roads were impassable. Nothing daunted, however, the native workmen took to pieces the Pelton wheel and its governor, the alternator including even the armature core plates, and also all the other machines, motors, pumps, etc., and carried the whole about a hundred miles up country. The plant was entirely erected by unskilled black labour, and worked without a hitch from the commencement. In the case of another larger multiphase plant for the Straits Settlements, this also was laid down by a single white engineer, assisted mainly by Chinese, and here again the whole thing went from start to finish without a single hitch. The writer very much doubts whether, if the generating plant had been steam and the electrical machinery of the continuous current type, the same results would have been obtained. Multiphase electric generators and motors, etc., are about as reliable as machinery can well be, and if it is possible to use Pelton wheels for generating the power, then the whole plant attains a simplicity quite unique, and just the thing for outlandish places, where skilled labour is scarce.

Pelton Wheel Governors.

The one tricky feature of a Pelton wheel is the governing device, for water under high heads is somewhat difficult to control on account of the great pressure. Thus, at 1,200 ft. head the pressure is over 520 lb., and with a 27 in. diameter steel pipe $\frac{11}{16}$ in. thick the bursting stress is nearly five tons per square inch, giving a factor of safety under normal pressure due to the head alone of 5 to 1. Now the inertia of a column of water moving rapidly through a long pipe is so enormous that any attempt to even partially shut off the water suddenly would certainly burst the pipe, The governing of the Pelton wheel must therefore be arranged so as to avoid any shock to the pipe line.

There are three methods of governing under high heads. The first is by means of stand pipes, to which the flow of water is diverted when shut off from the wheel, relief valves being also provided. The second, which is used largely in the States, is to deflect the jet or stream away from the buckets, the increase in speed of the centrifugal governor throwing a nozzle deflecting mechanism into action. The third is a method recently introduced by Mr. E. F. Cassel. In this system the wheel is divided along the centre line of the buckets into two sections, and the centrifugal force developed in the rotation of the wheel body itself is arranged to cause the two sections to separate slightly. A portion of the water jet is thus allowed to pass between the buckets, instead of impinging directly against them. Being part of the wheel itself, the governing action is instantaneous; it is self-contained, and has only four moving parts.

Of course, in the above the writer has been considering governing for sudden changes in load. Where the load is reduced or increased permanently, then the water can be *slowly* turned off or on, without danger, either by hand or by an additional governing device.

Expansion of Steel Pipe Lines.

One of the problems in connection with laying down steel-pipe lines for power purposes is the question of expansion. For example, with a difference of temperature of 100 degrees Fahrenheit, a steel pipe 100 ft. long will lengthen $\frac{3}{4}$ in., which means that a straight pipe a mile long will extend over three feet, Fortunately, when working under ordinary conditions with the pipe full of water, the difference of temperature is not likely to be so much as 100 degrees Fahrenheit, especially where the water is taken from a lake or mountain torrent. Again, the pipe is usually laid in a trench in the ground and covered with turfs, leaving only the joints exposed. This has also the advantage that the pipe is not so great an eyesore in the landscape. In the case of the Coolgardie pipe line, which, it may be mentioned, is 200 miles long, an ingenious method of keeping the temperature down is by whitewashing the line at frequent intervals. This method, of course, can only be adopted where appearance need not be considered, and in any case it is scarcely required except in tropical countries.

The expansion of the Coolgardie line is provided for by spigot joint rings, invented by Mr. Mepham Ferguson, having lead caulking. Messrs. Piggott and Co., the well-known Birmingham firm, use flanged pipes, and take up the expansion by inserting at intervals a short piece of corrugated pipe, somewhat similar to a corrugated boiler flue. The corrugations are liable to increase the water friction, but this can be obviated by inserting a thin steel liner inside the pipe.

ERRATUM.—On page 81 (January issue), first column, third paragraph, under the heading "Vertical *v.* Horizontal Water-Tube Boiler," read : "In the vertical type the feed-water enters the rear steam and water drum, passing down the rear bank of tubes," etc.

VERTICAL *v.* HORIZONTAL WATER-TUBE BOILERS.

THE remarks under the above heading in our January number must, of course, be taken as representing the point of view of the manufacturer of the vertical type boiler, and the statements were naturally *ex parte* ones.

To enter into a controversy as to the relative merits of horizontal and vertical water-tube boilers would occupy far too much space, and the subject has already been thrashed out in other technical journals.

The fact also that one firm of horizontal water-tube boiler manufacturers has already nearly 4,500,000 h.p. at work shows that these makers have, at all events, good arguments in favour of their type of construction.

To avoid misconception on the part of our readers, we would draw attention to the statement on page 162, that we do not necessarily share the views expressed by individual contributors, and it is only fair to point out that we dissociate ourselves entirely from the opinions expressed in the January number by the writer of "Power Station Notes."—ED.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Skimping of Spindles and Bearings.

The other day the writer's attention was drawn to an electric motor, which was satisfactory from the electrical point of view, but which had been most unwisely skimped in the mechanical details. It was, indeed, a technical school graduate's design, and the bearings in particular were quite out of proportion.

It is strange that manufacturers should cut down the bearings and spindles of electric motors, for the bulk of the money spent on these parts goes in the machining. It makes very little difference in material whether the bearing is 1¼ in. by 3 in., or 1½ in. by 4½ in., and the labour in the two cases would be about the same.

Again, some electrical motors have very small oil reservoirs under the bearings. In order that a motor may run for several weeks on end without attention, The oil reservoir must be of ample dimensions and the oiling ring dip well down below the surface, for when running the oil level drops considerably. Every care should also be taken to see that the oil-throwing rings and the recessed portion at the end of each bearing are of ample size to collect the oil properly and pass it back to the oil reservoir.

Rating of Motors and Starting Switches.

Amongst the many urgent matters which require attention at the present time is some system of rating electric motors and starters. On the Continent electric motors are divided into three classes, rated according to the nature of the load for which they are intended. Thus motors for *intermittent use* give the full horse-power stated on the output plate for one hour; those for *short-time use* have to give the full load for two or three hours, followed by a period of rest; and those for *continuous use* must give the full horse-power for ten hours without overheating. A good deal of the misunderstanding between contractors and customers in the matter of supplying motors for factory driving is due to the fact that we have no proper system of rating. Similarly, motor starters ought to be rated into those for *occasional use* that is, where the resistance can cool down, as, for example, where the motor is simply switched on after each meal-time; those for *frequent use*, where the motor is continually being switched on and off, as is the case when driving machine tools; and those for *continuous use*, which would include all speed regulators.

Regulations for Motor Starting Switches.

The regulations of our fire insurance offices and public supply companies, etc., with regard to motor starting switches are in most cases very stringent. For example, the maximum current which is allowed on the first contact of the switch is generally about five amperes, and some engineers require that a slow motion shall be provided to prevent the current being turned on too rapidly. Most fire insurance companies insist on the resistance being enclosed in an iron case, and another regulation occasionally met with is that the starting lever must be interlocked with the double pole main switch.

Some regulations are practically impossible of fulfilment, but generally speaking the tendency of these regulations has been to bring about a considerable improvement in the design of starting apparatus This is interestingly shown by the fact that English pattern starting switches have found their way on to the Continent, and are being adopted there in preference to the flimsy types which have been hitherto allowed.

Cost of Motor Starters.

The cost of a motor starter of the ordinary type, with metallic resistance, may vary from one-tenth of the price of the motor to as much as half the cost of the machine. On account of expense there is therefore a good deal to be said for the use of liquid resistances, particularly as they are so easily regulated. One point to notice particularly for direct-current motors is that the starter must be provided with a short circuiting switch contact for the "full on" position, otherwise the water will be electrolysed, and the solution require renewing more often. Under certain circumstances the gas might also prove dangerous.

To the writer's mind everything points to the fact that the alternating-current motor is bound to oust the direct-current type in the end, largely on account of this motor starting question. The alternating-current motor, for example, does not require to be taken care of, to anything like the same extent, as it is not necessary to provide the starter with a no load and overload release. Water resistances can also be employed without any electrolysis.

Variation in Speed of Direct Current Motors.

The direct-current motor to be marketable nowadays, must give not only a sparkless commutation, but this must be effected with the brushes on the geometrical neutral point between the pole tips, whether the motor is to be reversed or not. Under such conditions the machine depends for successful commutation mainly upon the carbon brushes, and to the employment of a very strong field relatively to the armature. This latter requirement is especially necessary where the motor is provided with the resistance in the shunt circuit, so that the speed can be varied, for in order to get *increased* speed there has to be a considerable *weakening* of the field.

In a recent article on this subject in the *Electrical Review*, Mr. H. M. Hobart has pointed out that a variable speed machine requires to be designed for good commutation at the highest speed and the highest current. He gives a curve showing that for a motor to commute well at all loads and speeds, and to be at the same time economical in design, there is for each size of motor a maximum speed which must not be exceeded. For 250-volt motors these speeds are:—

2½ h.p.	1,200
5 h.p.	1,000
10 h.p.	800
15 h.p.	700
22 h.p.	600
33 h.p.	500
50 h.p.	400
70 h.p.	350

For 500-volt motors the speeds should be a little lower, and for 125-volt motors they may be a little higher.

Country House Lighting.

With the cheapening of electrical plant and the improvement in small oil engines, there is likely to be a considerable extension in the use of ioslated plants for country house lighting. The writer does not mean large mansions, but the small farms, villas, and hamlets scattered about in country districts, and which have now to use oil. Such places are never likely to have a public supply, and there is generally a gardener or other manservant who can give the little attention required for a small installation. The whole matter seems to rest on the introduction of a cheap, and at the same time a "fool proof" battery, and the nearest approach to this latter desideratum appears to be the one now being made by Mr. Niblett.

One small point in connection with the installation of such an electrical plant is that the engine should be capable of being shut down from a bedroom or landing. By means of a push-button arrangement this could be done by shunting a portion of the current through an electrical magnetic device to turn off the oil cock. In this way the engines could be run up to the last moment, and the accumulator battery would not need to be so large.

Laying Cables on the Solid System.

When laying cables on the solid system the filling in material is usually a mixture of pitch and bitumen having a specific gravity of 1·5 to 2·0. Pure bitumen is, of course, a much better insulator, but it is too expensive to use by itself. On the other hand, pitch by itself is liable to be cracked by traffic passing over it. The kind of filling is not of great consequence, so long as it keeps out moisture and does not attack the lead covering or the cable insulation.

As a matter of fact, the weakest point of the system is at the wooden bridges, and there have been several breakdowns owing to bridges not having the moisture thoroughly driven off before being impregnated. Pot bridges can, of course, be used, but they are expensive. One important matter is that the cable should be prevented from creeping, owing to expansion and contraction. A cable has been known to pull itself straight between two bridges at a sharp corner until it became sufficiently decentralised to touch the inside radius of the iron troughing.

Expansion of Tram Rails.

It is surprising how widespread is the old story of the early railway contractor who butted the rails together with the result that when they expanded the whole lot, sleepers and all, lifted from the ballast and formed an arch. Knowing this story so well, it comes as a shock to the ordinary observer to see tramway rails not only being butted together but actually welded, as at Coventry, by the Falk cast joint, or at Leeds by the Thermit process, or the ends riveted together by a short piece of anchor rail.

It is no doubt difficult for the lay mind to look upon steel as elastic under tension and compression, but this is the explanation along with the fact that tram rails are entirely buried except for the tread, and are therefore only subjected to a difference of temperature of, say, 10° C. Professor Boyes has explained the matter by saying that a rail one mile long and free to move would expand 7 in. with a rise of 10° C., but that if compressed with a force of 3,130 lb. to the square inch it will retain its original length. Now, 3,130 lb. is only about 1½ tons, and is well below the elastic limit of steel, which is ordinarily specified for a breaking stress of twenty-five tons per square inch.

Very few roads, however, are absolutely straight for one mile, so we may consider the case of a curve of 100 ft. radius and rails weighing 100 lb. per yard, the rail section being 10 square inches. A change of 10° C. will change the total longitudinal force by as much as 31,300 lb., and the amount of this per foot run is simply $\frac{1}{100}$ of the longitudinal force of compression or extension if the radius of curvature is 100 ft. $\frac{1}{1000}$ 1,000 ft. radius, and so on. The road bed will therefore be under a side pressure of 313 lb. to the foot run, extending to a depth of 6 in. or 7 in. If the road is so unresisting as to allow the rail to shift laterally to such an extent as to relieve itself entirely of longitudinal stress, a movement of about ⅛ in. would be sufficient. Of course, in practice, the road would not be unresisting, but even if the rail did move an ⅛ in. in six months, and came back in the following six months, no harm would be done.

COMING EVENTS—FEBRUARY.

1st.—Society of Arts: Cantor Lecture.—Inst. of Mech- Engineers: Graduates' Meeting at 7.30 p.m.

2nd.—Institution of Civil Engineers: Meeting at 8 p.m.

4th.—Civil and Mechanical Engineers' Society: General Meeting at Caxton Hall, 8 p.m.—Birmingham University Engineering Society, Annual Dinner.

6th.—Birmingham Mechanical Engineers meet.

8th.—Edinburgh University Chemical Society: Ordinary Meeting.—Society of Arts: Cantor Lecture.

9th.—The University of Liverpool Engineering Society: General Meeting in the Lecture Hall at 5.30.—Institution of Civil Engineers: Ordinary Meeting, 8 p.m.

10th.—Mining Institute of Scotland: Meeting at Glasgow. —Liverpool Engineering Society at the Royal Institution.

11th.—Institution of Electrical Engineers: General Meeting. — Birmingham Local Students of the Institution of Civil Engineers: Meeting, Grand Hotel.

13th.—Manchester Association of Engineers: Forty-eighth Annual Dinner.—Birmingham Association of Mechanical Engineers: Annual Dinner.—North of England Institute of Mining and Mechanical Engineers: Meeting at Newcastle-on-Tyne at 2 p.m.

15th.—Society of Arts: Cantor Lecture.—Institution of Civil Engineers: Ordinary Meeting at 8 p.m.

18th.—Institution of Mining and Metallurgy: Meeting at Burlington House at 8 p.m.

19th.—Institution of Mechanical Engineers: Annual General Meeting.—City of London College Science Society: Ordinary Meeting.

20th.—North-East Coast Institution of Engineers and Shipbuilders: Meeting of the Graduate section at Newcastle-upon-Tyne.—Staffordshire Iron and Steel Institute: General Meeting.

22nd.—Society of Arts: Cantor Lecture.—Edinburgh University Chemical Society: Ordinary Meeting.

23rd.—Junior Engineering Society: Meeting at the G.W.R. Mechanics' Institution, Swindon.—University of Liverpool Engineering Society: General Meeting.—Institution of Civil Engineers: Meeting, 8 p.m.

24th.—Liverpool Engineering Society: General Meeting at the Royal Institution, Liverpool.

25th.—Institution of Electrical Engineers: General Meeting.—Leeds Association of Engineers meet.

26th.—North-east Coast Institution of Engineers and Shipbuilders: Ordinary Meeting.

27th.—Manchester Association of Engineers: Meeting.

29th.—Society of Arts: Cantor Lecture.

IRON AND STEEL NOTES.

By E. H. B.

The Development of Swedish Iron Ores.

The year 1903 will be memorable in the annals of Swedish mining for the opening of the Ofoten-Gellivaara line, which has established direct connection between the most northerly bay of the Gulf of Bothnia and the Atlantic. Direct access is thus afforded to the Norrland ores, the far-reaching importance of which has already been referred to in PAGE'S MAGAZINE. Of the principal orefields only, Kirunavaara-Luossavaara and Gellivaara will at present be in touch with the railway, according to *Affärsvärlden*, but the Sjanzeli fields, Nautanen, and Svappavaara will probably be connected with the trunk line in the near future. In *Affärsvärlden* a remarkable description is given of the great orefields of Kirunavaara and Luossavaara. The ore is magnetite, or magnetic iron ore. It forms, probably, two trunk ridges through the length of Kirunavaara and Luossavaara, and especially in Kirunavaara—is massed right up to the highest peaks of the mountain. The highest point of Kirunavaara is 749 metres, and of Luossavaara 729 metres above sea-level, corresponding to 249 and 229 metres, respectively, above the level of the lake of Luossajärvi.

Appearance of the Ore in the Field.

Almost everywhere the ore is well exposed, and on a walk along the mountain ridges the enormous deposits can be well observed. The ridge, covered at the base by birchwoods of small growth, rises as a sharply defined, dark-coloured crest above the brown marshes around. Having passed through the birchwood and over the thin gravel covering up to about one-third of the height of the mountain, one finds it quite bare, and the foot treads on the black ore, the surface of which is broken up in sharp-edged fragments. Impure ore seldom occurs.

The appearance of the ore in the field may, however, often give an erroneous idea of the extent of the deposit. It may look very rich on the surface, and yet be of relatively insignificant dimensions when the depth is examined, and *vice versâ*. This is, however, not the case at Kirunna. Investigations have shown that the ore forms a strongly raised layer, the richness of which diminishes very little in a downward direction. The average thickness in the ore ridge at a certain level has been calculated as 70 metres. The real thickness varies at different levels from 200 metres to 10 metres. The layer everywhere slopes towards the east. The steepest gradient is 67°, and the flattest, 45°.

Estimating the Supply.

These observations are of importance for estimating the ore supply. The official geologist, Mr. Lundbom, now manager of the Ore Company, arrives at the result that this supply amounts to 215 million tons, but this calculation is based on the supposition that the layer tapers downwards. If one might assume that the thickness is uniform right through, the quantity would be 265 tons. These figures are an indication of the colossal supply existing in Kirunavaara alone. Ore of similar quality, and occurring in the same form, is also found at Luossavaara. The ore quantity in this mountain, above the level of the Luossajärvi has been estimated at *eighteen million tons*.

Thus, taking the lower figure for Kirunavaara, we arrive at the respectable total of 233 *million tons* for the two mountains, not including the smaller layers occurring in many places, especially on the slopes of Luossavaara, and the unknown quantity, which probably exists under the lake Luossajärvi.

Methods of Working the Ore.

These layers of ore are unique, not only on account of their dimensions, but also for their quality and the unusual way geologically in which they occur. Unlike iron ore elsewhere, which occurs in slate-like rocks, this is embedded in a typic porphyry.

Interesting particulars are also given of the methods of working the ore. Both at Gellivaara and Kiruna the mining is done in open casts. At Gellivaara, however, owing, to the position of the layers, this work is combined with downcast shafts. The gradient of the layer being rather steep, the open-cast work can only be done to a depth of about 40-50 metres. It is then continued by shafts, which in some places have reached a depth of 200 metres. The ore is sorted in the mines according to the percentage of phosphorus. At Gellivaara there are six qualities, with a percentage of phosphorus from 0·02 to 2.

The sorted ore is sent down by an automatic railway, and put into big containers, from which the trucks are filled. There are two types of trucks, for 35 and 45 tons.

The Present Output.

The mining as well as the handling of the ore is more complicated at Gellivaara than at Kiruna, there being sixteen separate mines in the former place, at varying distances from each other, but the principle of the arrangements is the same in both places.

A large ore production, such as we have not before had in the Scandinavian countries, has been made possible by the systematic planning of the different sections of the work.

At Kirunavaara 3,700 tons ore are now loaded daily, equal to an annual production of one million tons. The production at Gellivaara has during the last few years been 800,000 to 900,000 tons, but it can no doubt be increased to one million. When the other rich ore deposits in Norrland, which cannot be now worked have been connected with the Ofoten railway, the total ore production will be considerably increased, and there will be an end to the talk about the slumbering millions.

Effect upon the British Iron and Steel Trade.

The possibilities of the North Scandinavian fields are, of course, well known to British ironmasters, a fact which was alluded to by Mr. Bennett H. Brough in the course of a lecture delivered to the members of the West of Scotland Iron and Steel Institute. Reviewing the present sources of iron ore supply, he remarked that while it was true that the richest ores at Bilbao had been exhausted, and that more attention had to be paid to calcination and to the washing of ores of inferior quality to enable them to meet market requirements, there need certainly be no immediate apprehension of a Bilbao ore famine. Far-seeing British ironmasters were, however, already making arrangements for the time when substitutes for the Bilbao iron ores would have to be found. And, happily, there were still large fields of ore, almost untouched, in Scandinavia, in Spain, and in the South of Spain, Algeria, Canada, Cuba, South America, India, and China. The future of the home demand was likely to be affected by the development of the basic open-hearth process of steel making, and there need be no immediate fear regarding the supply of the more impure ores suitable for that purpose. The lecturer remarked that in the year 1902 the world was literally ransacked for fresh iron ore fields to supply rich ores for the British blast furnaces.

A Retrospect.

In the course of a general review of the Iron and Steel and Engineering trades, covering 1903, the *Iron and Coal Trades Review* remarks that, although we can hardly classify 1903 as a satisfactory year, yet, on the whole, it shows an improvement on both 1901 and 1902; in fact, a considerable one on the first of these two, in respect, at any rate, to the volume of trade. Certainly business has not been so bad in most branches of these industries in the Middlesbrough district as it has been the fashion for many to make out during the past few months, whatever may have been the experience in other centres. It is true that there are certain departments which have been very hard hit by depression, and the manufacturers engaged in such branches have very good reason to be "down in the dumps," and to take a pessimistic view of the situation, for with them trade has never been so bad as it has been in 1903. The firms who have suffered so keenly have been those who have had to get their orders mainly from the shipbuilders, whose trade has not been so unfavourable for a good many years, and who are suffering partly from the extensive overbuilding in 1899 and 1900. But makers engaged in most other branches of the iron and steel industries have not had altogether a bad time—makers of foundry pig-iron, ironfounders, steel rail manufacturers, etc., have had a fair time, and we note increases in production and deliveries of iron ore, Cleveland pig-iron, and manufactured iron and steel other than that required in shipbuilding, though at slightly lower prices than were realised in 1902. But, after all, the manufacturers held their own very well during the year, and the fluctuations in values have been of small extent, which fact is exemplified by the small changes that have been reported in the wages of the men, which are regulated by sliding scale; some wages, in fact, have been stationary for considerably over a year.

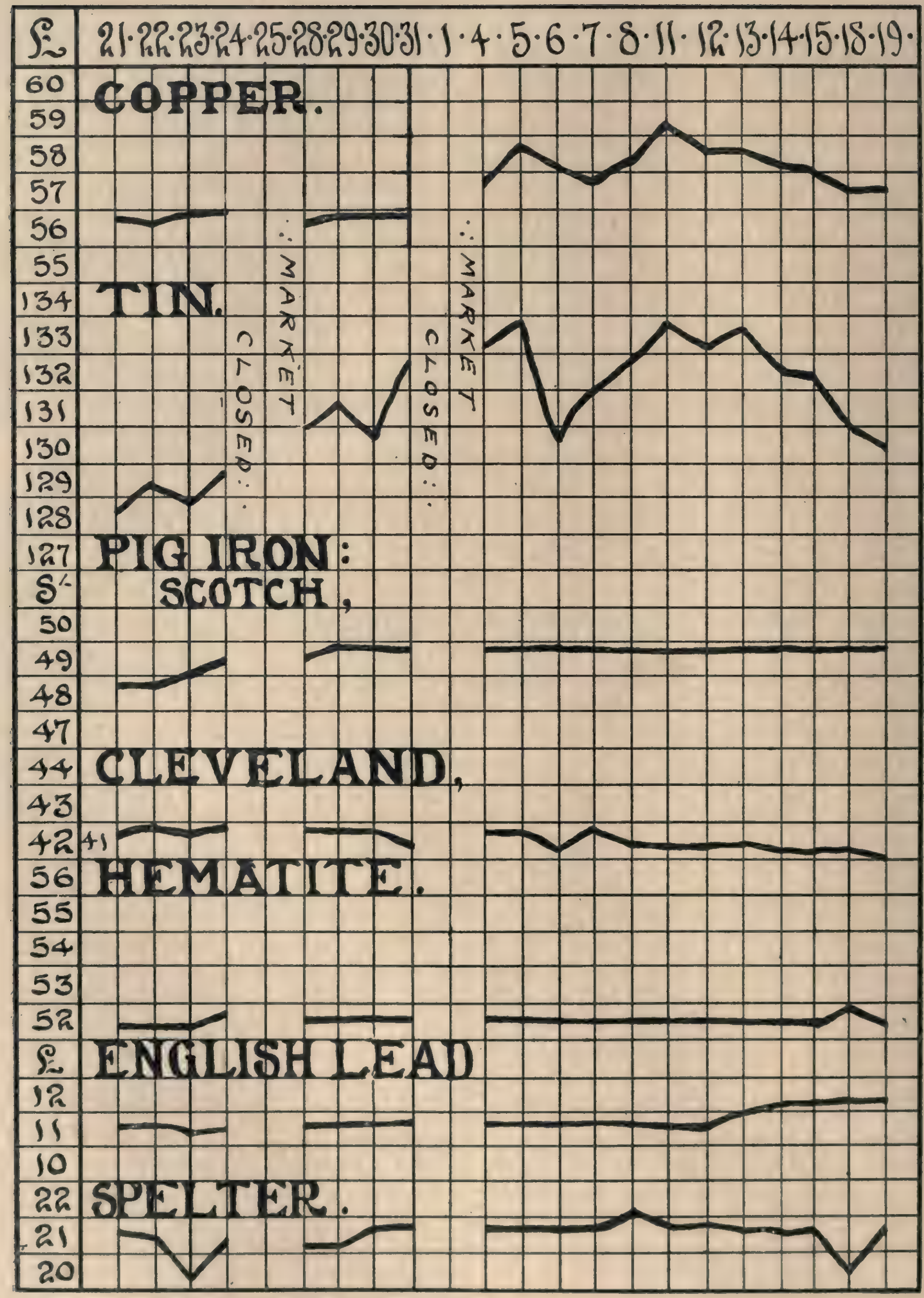
During the year we exported 3,571,373 tons of iron and steel, being 97,728 tons in excess of the exports of 1902, and 758,850 tons in excess of the exports for 1901, though in 1903 lower prices prevailed than in either of the two previous years.

Prospects of the American Iron Trade.

The outlook for the American iron trade in the coming year is not considered a very bright one, since, in addition to a reduced consumption, leaders of industry are confronted with the many perplexing questions which follow in the wake of a boom. What these questions are Mr. C. Kirchhoff concisely sets forth in the American monthly *Review of Reviews*:—

"So far as the probable volume of export sales is concerned," says this authority, "it is not well to indulge in very sanguine expectations. We are not the only ones who are dumping a surplus, nor are our plants so immeasurably better or our costs so much lower that we have foreign markets at our mercy. Our best works are, generally speaking, far ahead in labour-saving appliances, but we need that advantage to offset our higher wages. On the other hand, we are not as economical of fuel nor as careful of waste as the better works of our competitors. Besides, we must descend to the level of the world's neutral markets, which is considerably lower than our own. This must mean some sacrifice, even if due allowance be made for the fact that cost of manufacture is lowered by being able to keep plants at full employment. The moral effect upon home consumers of export sales at lower prices than those prevailing at home is another consideration which must be given some weight. To these very perplexing questions must be added that of lowering cost, to keep pace with shrinking values, with which is intimately coupled the readjustment of the relations with and the remuneration of labour. The price of raw materials, notably fuel, has already given way, and ore may be expected to follow when the time for making new season contracts arrives."

Another authority, the *Iron Trade Review*, is sanguine that with all the disappointments of the closing year the American iron trade enters upon 1904 hopefully, at least; and there is good reason to expect an improvement from the conditions of the past three months. What the railroads do will determine largely the turn of events. With a total of 2,200,000 tons of rails booked for 1903 or carried over from 1902, the rail manufacturers faced 1903 with abundant confidence. To-day they have scarcely more than one-third that tonnage. If the supply of money increases and a market for bonds again appears, so that new work can be financed on favourable terms, the railroads will resume buying iron and steel where they left off some months ago. In other consuming lines there is good evidence that the wait of recent months has been rather for a lower price than for lack of uses for material, and much withheld buying will come out now because it cannot be longer delayed. Indeed, enough business has accumulated in the period of abstention from the market to warrant considerably increased operation of steel works. Moreover, the great consuming West, with its unprecedented bank accounts and its millions of bushels of grain not yet turned into money, has a buying capacity that should be heard from in 1904.



THE HOME METAL MARKET.

Chart showing daily fluctuations between December 21st, 1903, and January 19th, 1904.

AUTOMOBILE NOTES.

The New Act.

The fact that the new Act had come into force was almost immediately noticeable in the metropolitan streets by the advent of the conspicuous numbers, which are now such a feature in automobile traffic. The hostility of certain rural district councils has afforded material for many amusing paragraphs in the Press, and, as might have been expected, some of them do not seem to fully realise the exact limits of their restrictive powers. Happily, however, the zeal of these small anti-motoring councils will be subject to the restraining influences of the county councils. The numbering thus imposed by the new regulations may be unsightly, but it will unquestionably do much to repress the "road hog," and at the same time it is likely to minimise the feeling of antipathy with which motor cars are regarded in some of the rural districts. The speed regulations are another matter. It would rather seem that the duties of the chauffeur will, in course of time, bear some similarity to those of the railway engine driver, and to avoid trouble he will have to know his routes equally well.

Side Slip.

As announced last month, it is proposed by the Automobile Club to hold a novel competition for devices designed for the prevention of sideslip. Every motorist will recognise the utility of such tests, but it seems probable that there will be considerable difficulty in carrying it out, and we shall be somewhat interested in following the arrangements of the organisers. The question is one into which practical experience largely enters, and if any of our readers are able to offer suggestions for the more efficient carrying out of the proposed tests, or can indicate a thoroughly suitable spot for carrying them into effect, we shall be glad to forward such particulars to the promoters.

Endurance Test.

The Automobile Club of America will probably go in for an endurance test during the coming month, when the machines entered will have to encounter snow, ice, and mud, the idea being to test the capacity of the machines as all-the-year-round vehicles. It is said that the manufacturers will welcome the thoroughly effective tests proposed, for they believe that they have very nearly achieved success in making a serviceable vehicle for commercial use at a reasonable price, and are anxious to secure perfection in their machines.

Motor Transport.

A writer in *The South African Mines, Commerce, and Industries*, criticising a recent article in PAGE'S MAGAZINE on Motor Transport, points out that a comparison between mechanical and horse-drawn transport in say, America or England, would not hold in regard to South Africa. There are, of course, factors peculiar to this country which have to be counted on both sides of the calculation, factors which readily suggest themselves and need not be enumerated. The balance of advantage in innumerable cases is believed to be on the side of mechanical transport; but the growth of this form of transport is bound to be more or less slow.

Retrospect and Prospect,

The *Motor* is not able to speak very enthusiastically about the past year. The disastrous Paris-Madrid race, the loss to England of the Gordon-Bennett Cup, and the degradation of the number plate, are all spoken of in regretful strain. Only in one direction was there a gleam of sunshine. This was to be found in the steady growth of motoring among men of moderate means, and the *Motor* is more convinced than ever that in the direction of the light and popular priced car lies the prosperity of the British automobile industry of the future.

Mr. S. E. Garcke, in the course of a review of the Motor Industry, remarks that although many of the best makes of large cars were not exhibited at the November shows—the majority of manufacturers reserving themselves for the shows in February and March—a few were to be seen. Among others, the well-known makes of Beaufort, Talbot (British Automobile Syndicate), Darracq, Sunbeam (John Marston, Ltd.), had good shows. It is mentioned as an illustration of the enormous growth of the motor industry, that A. Darracq and Co. are constructing over 1,000 cars for 1904, ranging from the 8-h.p. single-cylinder to the 30-h.p. four-cylinder.

The *Motor Car Journal* prophesies a busy coming season, not only as regards motor-car competitions, but also in connection with the motor-boat movement. At Cannes, Monaco, and Nice, as well as other pleasure resorts, races are being organised. M. Paul Meyan, of *La France Automobile*, has just offered a cup to the Club Nautique de Nice, which is to be competed for on April 17th next. To become the winner's own property the cup must be won two years in succession. The race, which is to be over a distance of 100 kilometres, is international, each country being, however, only permitted to have in the race one boat, the length of which must not be more than 40 ft. Any number of entries can be sent in from each country, and a series of eliminating races will be held to select the boat to compete in the cup race. Entries are to be sent to the Club Nautique de Nice, 93, Quai du Midi, Nice, before March 30th next.

The future of the Electric Motor Car is discussed in an interesting manner by a correspondent of *Electrical Investments*. For greater freedom and independence the owner of an electric car is bidden to look to Mr. Edison. Says the writer,—we have weighty authority for the statement which is now, we believe, published for the first time, that during the early part of the year 1904, steps will be taken to put the Edison accumulator on the market on a large scale. A factory is to be erected in this country to supply the British demand, which is sure to be very large if the invention is only half as wonderful as it is claimed to be. Our information is that the result of the most severe tests has been such as to astonish eminent experts, who are now convinced that Mr. Edison has solved the problem. The Edison accumulator, we are told, is so much more serviceable than any competitor on the market that it will at once enlarge the range of the electric car to such an extent as to make it a thoroughly reliable long-distance vehicle.

Automobiles in Canada.

According to a Board of Trade report, automobiles have received a good start in Canada. It is expected they will be very common next summer. Practically all of the machines used there at the present time are manufactured in the United States, and a great number of different manufacturers of automobiles are represented. Automobile manufacturing in Canada has not attained any volume at present, but several enterprises are likely to take up the industry.

AMERICAN RÉSUMÉ.

BY OUR NEW YORK CORRESPONDENT.

NEW YORK, January 19th, 1904.

The World's Greatest Suspension Bridge.

The opening of the Williamsburg Bridge at New York on December 19th, marks the successful completion of a great undertaking. The accompanying plan, for which we are indebted to the *Engineering News*, affords an interesting comparison between the Brooklyn Bridge and the structure which has just been thrown open to the public. An article on the Williamsburg Bridge, by W. B. Northrop, appeared in the October, 1902, issue of PAGE'S MAGAZINE.

Great Engineering Works.

In the course of an article on the engineering outlook for 1904, one of our contemporaries mentions that in the coming year several great engineering works will probably be inaugurated, which will call for all the resources and inventive talent of both civil and mechanical engineers. In this category the writer includes the construction of the Isthmian Canal; the plan of the Pennsylvania Railroad Company to connect its system with the cities of New York and Brooklyn by tunnelling under the Hudson and East Rivers, and the work on the Grand Trunk Pacific Railway, which, by the way, is to be a model for twentieth century railway practice.

The Panama Canal.

The establishment and recognition by this country of the new-born Republic of Panama, says *Marine Engineering*, has settled for all time the question of a trans-isthmian waterway and the part in which this country is to take in it. Our Government will now construct the Panama Canal, and that right speedily, so that within a few years we may expect to see this great waterway open for commerce. It is reasonably anticipated that this will be immediately followed by an immense expansion of trade between our Pacific and Atlantic States, and a new field of commerce will be opened for merchants on the western coast of South America."

It is asserted in some quarters that the unhygienic conditions and intolerable heat of the Isthmian climate will add materially to the bill of cost. It is stated that the Panama Isthmus is not only unfit for colonisation, but life there is a constant battle against unhealthy conditions.

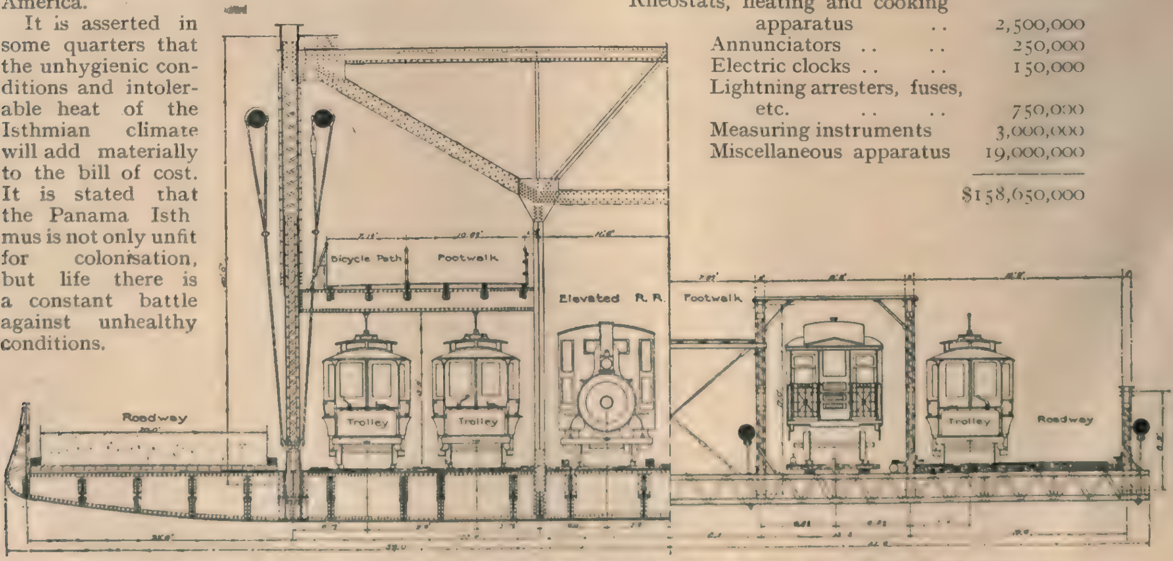
A Novel Application.

Slack time constitutes an evil which is common enough in certain places, but that a city engineer should appeal to have his salary cut down in consequence thereof, is an altogether new phenomenon. At Fargo, No. Dak., Mayor Sweet reported to the council that Acting City Engineer Atkinson felt that the work of his office during the winter months was not of sufficient quantity to demand the whole of his time, and was so unimportant that he did not think he should accept the $100 per month salary, and had asked that it be cut to $50. The council did not look upon the matter very kindly, and Aldermen Schruth, Cummings and McKellar expressed themselves as believing that Mr. Atkinson's services as engineer were well worth what it costs the city. As the salary was fixed by ordinance it was their opinion that it should not be changed.

American Electrical Apparatus.

An estimate of the production of electrical apparatus in this country during the past year works out, according to the *Electrical World and Engineer*, at $158,650,000. the figures are as follows :—

Dynamos	$17,000,000
Transformers	5,000,000
Switchboards, for lighting and power	2,750,000
Motors for all purposes	30,000,000
Storage batteries	4,500,000
Primary batteries	1,250,000
Carbons	2,000,000
Arc lamps	2,250,000
Incandescent lamps	5,500,000
Lighting fixtures	3,750,000
Telephonic apparatus	25,000,000
Telegraphic apparatus	2,000,000
Insulated wires and cables, submarine cables	30,250,000
Conduits, interior and underground	1,750,000
Rheostats, heating and cooking apparatus ..	2,500,000
Annunciators	250,000
Electric clocks	150,000
Lightning arresters, fuses, etc.	750,000
Measuring instruments	3,000,000
Miscellaneous apparatus	19,000,000
	$158,650,000



HALF-SECTIONS OF THE NEW WILLIAMSBURG BRIDGE AT NEW YORK, AND BROOKLYN BRIDGE.

SOUTH AFRICAN RÉSUMÉ.

By our Johannesburg Correspondent.

JOHANNESBURG, January 11th, 1904.

De Beers Consolidated Mines.

The annual report of this company contains, as usual, many items of interest to engineers and mining men. For instance, it mentions that the company has just completed, at a cost of £80,000, a central electric station, from which power is to be distributed to the underground machinery as well as to the washing plants, haulage gears, etc. The installation has been supplied by Messrs. C. C. George and Co., of Johannesburg, representing the Westinghouse Company of America. The lighting of the mines, floors, offices and plants of the company is supplied from the same centre, and it is proposed also to deliver current for lighting purposes to the immediately adjacent townships of Kimberley and Beaconsfield. A suggestion is also made in the report that it may be possible to run an electric tram to Alexandersfontein, the favourite pleasure resort of the Diamond Fields community, where an hotel has been erected by the company at a cost of £25,000. This last fact shows how far-reaching is the interest taken by the company, not only in the work of its employees, but also in the recreation of themselves and their families.

Values and Yields of the Griqualand West Diamond Mines.

The following table, compiled from figures given in the report already mentioned show the quantities and values of the diamonds found per load of blue ground washed during the past year, for the several mines in the district. One load contains 16 cubic feet of material :—

Name of Mine.	Average yield per load in decimals of a carat	Average value per carat.			Average value per load of blue.		
		£	s.	d.	£	s.	d.
De Beers and Kimberley Mines ..	0·61	2	8	6·3	1	9	9·8
Premier Mine, Wesselton ..	0·30	1	14	4	0	10	3·2
Bultfontein Mine ..	0·24	1	10	10·2	0	7	5·4

The total output for the twelve months realised £5,241,172.

It is interesting to compare these figures with those of the mines in the Transvaal, where the average production per load has been a little over one carat per load. The average value for a year's yield is £1 7s. 7·4d. per carat, and the total value for the same period only £46,358. The value per load works out at about £1 11s. 3d., or just a little higher than the average of the De Beers and Kimberley mines.

Native Convict Labour on the Rand.

A great deal of the work on the De Beers floors is performed by convict labour supplied by the Cape Government, and as this arrangement has worked satisfactorily for many years it is not surprising that some of the black convict labour available on the Rand should also be used for mining purposes. The Transvaal Government have supplied 1,500 convicts already with the stipulations that they shall be kept in separate compounds, apart from the free labourers, shall be employed for surface work only, and shall receive 1s. 6d. per day. Quarters for the guards have also to be provided by the mining companies.

Native Labour Commission and the Minority Report.

A brief account of the findings of the native Labour Commission was included in the December number of Page's Magazine. It will suffice, therefore, to direct attention to the following summary of requirements :—

	Estimated number required.	Now at work.	Shortage.
Agriculture ..	80,000	27,715	52,285
Mining	197,644	68,280	129,364
Other industries ..	69,684	69,684	No data obtainable.
C.S.A. Railways ..	—	—	—
Open lines	16,000	12,402	3,598
New Construction ..	40,000	3,848	36,152
	403,328	181,929	221,399

All these figures, except those for the railways, which include the Orange River Company lines, are for the Transvaal only. No estimate could be arrived at from the available evidence as to the future development and consequent labour requirements of "other industries," and the Commission has not hazarded a guess at the probable shortage under this head. Even at this moment therefore, according to the above tabulated summary, we are confronted with a deficiency of more than half the number of labourers actually and urgently required.

The estimate of the two gentlemen who differed from their ten colleagues was stated as follows :—

Witwatersrand gold mining	91,000
Witwatersrand coal mining	12,000
Other districts gold mining	12,250
Railways	20,000
Agriculture	55,000
Other industries	69,700
	259,950
Subtract number now at work as above ..	181,929
Present shortage according to minority report	78,021

Striking an Average.

To allow for any unconscious bias on either side, we may take the mean of the two figures, namely 149,760 as being practically unassailable. Now, on November 30th, 1902, there were 45,445 natives working on mines, and on October 31st, 1903, there were 74,609. The average monthly increase has therefore been 2,514. As the mining requirements are about half the total in each set of figures given above, we may estimate the total increase at 5,000 per month. If this rate of increase could be maintained, it would require two and a half years to obtain our *present* requirements. But this means absolutely no expansion of industrial effort in any direction. Therefore, it is quite evident that, after allowing due weight to the figures of both parties, an importation of labour, as stated in our November notes, is essential to the progress of the Transvaal and the Orange River Colony.

GERMAN RÉSUMÉ.

BY

DR. ALFRED GRADENWITZ.

BERLIN, January 21st, 1904.

Wireless Telegraphy from Running Railway Trains.

Experiments recently made by Professor Biscan, Teplitz, Austria, with a view of using wireless telegraphy apparatus from running railway trains, are said to have, so far, given quite satisfactory results, wireless despatches being safely received and transmitted over distances as high as 7 kilometres from the station erected in Teplitz. The possibility of ensuring wireless communication with running railway trains has thus been evidenced. The car containing the apparatus was coupled to the back of the train, two wires leading outside of it. These wires were conveyed horizontally on both sides of the roof of this car and of three ordinary railway cars, terminating in a horizontal free point; they were intended to replace the antennæ otherwise used in connection with wireless telegraphy stations to enforce the effects of electric waves. As soon as the train approached the Teplitz wireless telegraphy station up to the distance above mentioned whence a continuous supply of despatches was to be given, the telegraph apparatus in the car would begin working, the paper ribbon containing the telegrams running off the roller in a manner quite analogous to an ordinary telegraphic apparatus. Similar experiments have, by the way, been carried out some time ago on the Berlin-Zossen military railway.

Wireless Telegraphy Experiments.

The Berlin Gesellschaft für drahtlose Telegraphie has installed on the Norwegian Loffoden Islands two wireless telegraphic stations at a distance of 50 kilometres, the points chosen being separated by high and continuous rocky masses so as to oppose material obstacles to the passage of the electric waves. These experiments were made with a view of testing the safety of the system under especially unfavourable conditions. The above stations were operated by means of dry cells so as to ascertain whether very small amounts of energy would allow of communication being secured over the distance of 50 kilometres. On account, however, of the obstacles interposed in the direction of telegraphing, the primary energy of a limited number of dry cells was found to be insufficient, an amount of energy as high as about 200 watts being necessary to ensure a regular communication. On the other hand, the above company had some weeks ago made attempts to obtain wireless communication from their large station at Oberschöneweide (near Berlin) as far as Munich and Vienna. On account, however, of the heavy storms prevailing these experiments had to be discontinued, the storm in Berlin tearing off the balloon carrying the antennæ from the rope. In Munich it was equally impossible to send up balloons or kites because of the violent storm. The experiments which were contemplated for some time between the Oberschöneweide station and Karlskrona, Sweden, were commenced on the 16th inst., and, as far as is known, have given satisfactory results.

Strength of Steel Castings at Ordinary and High Temperatures.

The experiments by C. Bach, described in a paper recently published in the *Zeitschrift des Vereins Deutscher Ingenieure* are intended to ascertain the dependency of the mechanical strength of steel castings on temperature; they are relative to castings from three different works, being distinguished by the letters O, K, and M, respectively. It is shown in the first place that the average tensile strengths will augment up to about 300° C.; the author does not note any appreciable influence of the duration of the load. For higher temperatures, on the other hand, the mean tensile strengths are found to increase, viz., for loads lasting about half an hour:—

For casting O from 4,788 (300° C.) down to 2,691 kilogramme-square centimetres (500° C.); K, from 4,242 (300° C.) down to 2,043 kilogramme-square centimetres (500° C.); M, from 4,319 (300° C.) down to 2,274 kilogramme-square centimetres (500° C.)

For more prolonged loads (about 8-12 hours) there is a decrease in the tensile strength, being at 500 C.: for casting K from 2,043 down to 1,561 kilogramme-square centimetres; M, from 2,274 down to 1,911 kilogramme-square centimetres.

As regards, on the other hand, the individual values for the tensile strength, there are in the case of castings O, the lowest departures at ordinary temperature and the highest departures at 300°, whereas, in the case of K and M 100° and 20° respectively will correspond with the minimum departures, and 200° and 100° with the highest departures.

The average fracture tensions are found to decrease in the case of casting O, from 25·5 per cent. (20° C.) down to 7·7 per cent. (200° C.); K, from 29·0 per cent. (20° C.) down to 17·7 per cent. (200° C.); M, from 27·2 per cent. (20° C.) down to 15·2 per cent. (200° C.).

For temperatures upwards of 200°, the average fracture tension will augment again up to 33·3, 51·3, and 26·1 per cent. respectively, at the temperature of 500°.

Prolonged loads will result in the tension being lowered at 300° and 400°, and augmented at the temperature of 500°.

The individual values for the fracture tensions show departures among one another, which augment in some cases at extraordinary rates, for increasing temperatures.

The average contractions of the cross section are found to decrease up to 300°, this decrease being for casting O, from 50·4 (20° C.) down to 15·8 per cent. (300° C.); K, from 56·1 per cent. (20° C.) down to 49·4 per cent. (300° C.); M, from 48·7 per cent. (20° C.) down to 34·7 per cent. (300° C.).

At higher temperatures there is once more an increase, values as high as 44·6, 75·7, and 42·1 respectively being noted at the temperature of 500°. There is moreover, an influence of a prolongation of the load. The departures noted between the individual values are rather high.

From the above it is inferred that a steel casting, while appearing to be a very satisfactory and fairly uniform material with respect to its tenacity at ordinary temperatures, may present little tenacity and uniformity at high temperatures. This behaviour should have an important bearing on the construction of steam boilers, etc., where the strength corresponding to ordinary temperatures is less important than that corresponding to high temperatures.

The Pielock Superheater.

Superheaters have been adopted in connection with locomotives relatively late, in fact long after their use with stationary steam boiler and steam engine plants had been shown to be advantageous. In 1898 the Prussian Railway Administration caused extensive experiments to be made in connection with hot steam locomotives; these experiments resulted in the superiority of the hot steam locomotive, as compared with the wet steam locomotive being demonstrated. Now present superheater types, while fully meeting the requirements of a safe operation, cannot be installed without expensive reconstruction, except in the case of a newly constructed locomotive, necessitating even in the latter case a not immaterial cost (with the Prussian 2/4-high-speed locomotives about 300 to 400).

The Pielock superheater, just brought out by the Hannoversche Maschinenbau A.G. vorm. Georg Egestorff, Linden, near Hanover, is remarkable for its simplicity and suitable arrangement, in addition to its low cost. This superheater is designed not only for locomotives, but for nearly any heating tube boilers, being readily installed in connection with new as well as with existing boilers. In the case of locomotive superheaters, the apparatus is placed in the multitubular boiler, using the existing heating surface of the tubes so as to have the fire gases, necessary to superheat the steam, enter the superheater at a convenient temperature, sufficient to obtain the required steam temperature with a minimum heating surface, while being sufficiently cool to prevent the fire gases exerting any noxious influence on the tube.

The superheater consists mainly of a box, surrounding the existing tube system in the boiler, being readily tightened against the surrounding water as the pressures in the superheater box and in the boiler are identical. This box is divided by partition walls into different compartments, this ensuring a contact as prolonged and as intimate as possible between the steam and the heating tube. The steam enters the superheater box at boiler pressure, traversing the various compartments and entering a box surrounding the governor head. The temperature of the superheated steam is indicated by a thermometer provided with big figures, so as to be easily read from the mechanic's stand. A tube leading from the governor through the dome foot serves to supply superheated steam to the air pump, as well as for cleaning the rails, heating, etc. In the case of any disturbances being noted, the amount of leakage of the superheater may be ascertained.

Experiments so far made on the Pielock superheater have fully borne out the hopes entertained regarding it. In connection with experiments made on behalf of the Russian railway authorities, a saving of coal as high as 15 per cent., and of water as high as 18 per cent., was stated, as compared with similar locomotives fed with wet steam. In virtue of the reduced space of the superheater, any desired temperature up to the maximum of 300° to 350° may be obtained, according to the position and length of the apparatus.

Statistics of German Electricity Works.

The returns published in a recent issue of the *Elektrotechnische Zeitschrift* are intended for ascertaining the present development of electricity works in Germany according to their dimensions and outputs, technical and economical problems being excluded on account of the difficulty met with in getting such information through a private *enquête*, the starting capital being only excepted. As regards the results to be derived from these statistics, we note that in 1903 there existed in Germany fifty electricity works of an output of upwards of 2,000 kilowatts, the two largest being Berlin-Moabit (26,523 kilowatts), and Berlin-Oberspree (25,425 kilowatts). The total output of these fifty largest central stations belonging to thirty-seven cities is 271,479 kilowatts. The increase in the amount of connections in all the works is shown by the following table:—

	Total No. of weeks.	No. of 50 W. glow lamps.	No. of 10 Amp. arc lamps.	No. of motors connected. h.p.
1894	148	493,801	12,357	5,635
1895	180	602,986	15,396	10,254
1897	265	1,025,785	25,024	21,809
1898	375	1,429,601	32,586	35,867
1899	489	1,940,744	41,172	68,629
1900	652	2,623,893	50,070	106,368
1901	768	3,403,205	64,278	141,414
1902	870	4,200,203	84,891	192,059
1903	939	5,050,584	93,415	218,953

Among the 939 works recorded, there is a large number of overland centrals, the current supply of which, so far from being confined to a certain local district, is extended to a considerable number of places. In this connection the Brühl central station of the Berggeist Limited Company should be mentioned, supplying sixty-six localities in a circle 15 to 20 kilometres in radius with current for light and power purposes, as well as the Upper Silesia electricity works supplying the whole of the industrial district of Upper Silesia, and the Rheinfelden power transmission works supplying forty-six localities. Some of the large tramway companies, it is stated, have decided on transforming their tramway central stations into such overland centrals. Moreover, there is in the Rhenanian industrial districts a number of smaller electricity works serving especially for the small and domestic industry. In the Anrath electricity works, near Crefeld, for instance, the motors connected are all of ¼ or ½ h.p., being used in the domestic industry for operating silk ribbon looms.

Whereas in Switzerland, there is a large number of so-called secondary works selling the current supplied from a larger central. The only similar works in Germany, as mentioned in these statistics, is the municipal electricity works of Spandau, near Berlin, where the Berlin-Moabit electric station supplies the current to the town, selling the same to private persons.

MINING NOTES.

The Penetrating Pulley.

A brief account of this appliance was given by Mr. Bennett H. Brough in the course of one of the Cantor lectures on The Mining of Non-Metallic Minerals. The wire saw was applied at Carrara for sub-dividing blocks of marble, but the impracticability of using the revolving cylinder, or hand labour for sinking inclined pits, was an obstacle to its further use. The difficulty was, however, overcome by Mr. Monticolo, who invented an ingenious appliance, which he termed a penetrating pulley, with which it is possible to replace the somewhat costly pit by a bore-hole 3 in. in diameter. The penetrating pulley consists of a disc 20 in. in diameter, and ¼ in. thick, with a semi-circular groove round its periphery, deep enough to take half the thickness of the wire, the other half projecting. The disc is mounted on a pivot, and is supported by a hollow steel shaft of slightly smaller diameter than the bore-hole. To the shaft is attached a series of tubes of equal diameter, forming a column that may be lengthened at will, in the interior of which is a fine tube, serving for the lubrication of the pivots. As the cut deepens the pulley is fed down automatically by means of an eccentric. For cutting a groove, two bore-holes, to receive the shafts carrying the axes of the pulleys, are first made by hand or by the diamond drill. The pulley was first applied in March, 1898, at the Campanile quarry, Carrara, where cuts have been made 50 ft. long and 16 ft. deep, inclined at an angle of five degrees from the horizontal. The highly satisfactory results obtained with the penetrating pulleys serve to show that there is a great saving of expense by the substitution of bore-holes for pits, far less waste of valuable marble, increased rapidity of quarrying, and consequently increased output.

Slate Quarrying with the Wire Saw.

Mr. Brough incidentally referred to the wire saw method of slate quarrying. He remarked that at Rhiwbach, Mr. H. Humphris has introduced an ascending method of working in which all the rock available is procured at low cost. Small cross levels, 4 ft. wide and 8 ft. high, are driven at right angles to the main level. As soon as two of them are 25 to 30 yards long, the rock between is undercut by the wire saw, and top cut at a height of 6 ft. above. The block is sliced off and rough dressed underground. The waste produced is stacked up to the level of the roof, so as to form the floor of the next gallery. At Labassère, in the Pyrenees, the wire saw is employed to make horizontal cuts across the inclined beds of slate, severing great blocks without blasting. Believing that a similar system could be employed with advantage in North Wales, Sir C. Le Neve Foster recommended that Mr. G. J. Williams, Assistant Inspector of Mines, should study the question on the spot. The Home Secretary having acceded to this suggestion, Mr. Williams drew up a very valuable report, which was published in 1900. The investigation clearly showed that slate might be worked in many quarries in North Wales by the wire saw method with great advantage. There would be less blasting, fewer falls of ground, less waste of good rock, reduced cost of working, less cost of explosives, a saving in the cost of unproductive work, a saving in the cost of removing rubbish, no need for quarrying worthless rock in underground workings, and the cost of examining and securing the roofs and pillars would be done away with. An article on this subject appeared in PAGE'S MAGAZINE last August.

A New Coalbed.

In the Department of Yoro, in Honduras, a new coal bed has been discovered. Expert examination and test of several samples of the coal taken from or near the surface establish the claim that it cokes with excellent result, but coal taken from a depth of 2 ft. or more exhibited much better qualities, being firm and lustrous. It is, therefore, believed that at a depth of from 50 to 100 ft. the deposits should be found to possess all the requisites of first-class coal. As there are no other coal-fields of value in that part of the continent, it is anticipated that the exploitation of this property will carry with it profitable returns, as well as inaugurate a new industry in a region now but sparsely populated.

Production of Asphaltum and Bituminous Rock in 1902.

The production of asphaltum and bituminous rock in 1902, according to the report of Dr. Joseph Struthers to the United States Geological Survey, showed a large increase over that of 1901, amounting in quantity to 36,525 short tons and in value to dols. 122,259, the figures for the two years being, respectively, 99,659 short tons (677,594 dols.) and 63,134 short tons (555,335 dols.). The relatively smaller increase in value, as compared with quantity, was due to the very large proportion of bituminous sandstone produced.

The production of hard and refined asphaltum increased from 19,316 short tons in 1901 to 22,321 short tons in 1902. The production of liquid asphaltum, all of which was derived from California, decreased from 2,600 short tons in 1901 to 1,605 short tons in 1902. The quantity of asphaltum produced in the refining of crude oil during 1902 amounted to 16,027 short tons.

The imports in 1902 amounted to 153,093 long tons (492,604 dols.) as compared with 138,833 long tons (553,473 dols.) in 1901.

The report contains a brief abstract of the production of asphaltum in Cuba in 1901.

The Chinese Labour Question.

Dr. Jameson, in the course of his speech at Grahamstown, defined his own attitude towards the Chinese labour question. He said that he was opposed to the introduction of Chinese, but, he added, "we cannot dictate outside our own borders." He would, he said, introduce legislation to prevent Chinese from entering Cape Colony. As we go to press we hear that the draft ordinance for the introduction of Chinese labour into South Africa has just been read in the Transvaal Legislative Council. There is still a strong bias against the proposal in some quarters, notwithstanding the numerous safeguards which have been introduced into the scheme. Mr. Seddon has been particularly active in his hostility, and we are face to face with the somewhat unusual spectacle of two Colonial Premiers—Mr. Seddon and Mr. Deakin—going out of their way to protest against a measure affecting a portion of the British Empire, it is true, but in no way connected with their own spheres of influence. I notice that our Johannesburg correspondent makes a further allusion to this question, and as a close observer on the spot his opinions are certainly entitled to some weight. He is emphatically for the introduction of Chinese labour.

OPENING FOR BRITISH TRADE

British India.

The Public Works Department of the Kashmir and Jammu State invite tenders for an electric power installation in the neighbourhood of Srinagar, Kashmir. The maintenance and up-keep of the whole plant for at least one year after completion of the works will have to be included in the tenders. Further particulars can be obtained from the State Engineer, Kashmir Durbar, Srinagar.

Natal.

The Governor of the Colony has been empowered to construct departmentally, or contract for a line of railway commencing by a junction with the existing line at or near the North Shepstone Station, and ending at or near the mouth of the Umhlangeni River, in the county of Alfred; also a line of railway commencing by a junction with the existing line at or near the Ennersdale Station, and ending at or near the "Honger's Poort" Magistracy, on the north side of the Tugela River, in the county of Klip River.

Netherlands.

Tenders for the erection of a telescopic gasometer at Amsterdam having a diameter of fifty metres and a capacity of 60,000 cubic metres, will be opened on the 15th inst.

Spain.

The Government has granted a concession for the construction and working for ninety-nine years, without State subvention, of a narrow-gauge railway, from Puebla de Hijar, by Morella, to the port of Vinaroz, with a branch for the working of the coal measure of Utrillas and another for that of Beceite.

Concessions have been granted, without State subvention, for the following:—

An electric tramway for passengers and merchandise from the city of Orense to the town of Verin, for sixty years. A railway from the high road from Ainzón to Illueca in the district of Tierga, to the station of Morata de Jalón, on the line of railway from Madrid to Zaragoza, for ninety-nine years.

A narrow gauge railway from Alcázar de San Juan, by the towns of Herencia, Villafranca, Camuñas, Madrilejos, Consuegra and Turleque, to Mora de Toledo, for ninety-nine years. A narrow-gauge electric railway from Madrid to Arganda, for ninety-nine years.

Portugal.

The Ministry of Public Works, Lisbon, require tenders for the construction of a pier for loading and discharging, with the works corresponding in the port of Lagos at the upset price of 31,000 milries (about £5,200).

Russia.

In view of the development of traffic over the railway system, it has been decided to double the track of each of the following lines:—Warsaw-Malkine, Warsaw-Otvotsk. Sineinikovo-Alexandrovsk, Kramatorskaïa-Popasnaïa, Korostovska-Zélénaïa, Rostov-Kavkazskaïa, Eaux-Minérales-Prokhladnaïa, and Zamtchalovo-Schakhtnaia.

A despatch has been received at the Foreign Office, from Warsaw, stating, in connection with the new slaughter-houses and other public works, that there appears to be a good opening for the supply of mechanical parts for the new bridge, and for the supply of ventilators and heating apparatus for the market halls.

Mexico.

A concession has been granted to Messrs. D. J. Arce and F. F. Castello to construct and exploit for the term of ninety-nine years a railway, 914 millimetres gauge, from Tlal'pujahua, in the State of Michoacan, by way of a point near Villa del Oro in the State of Mexico, to Anganguco in the State of Michoacan with such branches as may be necessary, not exceeding 40 kilometres, to open communication with the mineral districts, forests, and villages in the States of Michoacan and Mexico.

New Zealand.

Tenders will be received at the Office of the Christ church Tramway Board, New Zealand, on or before March 17th, 1904, for the complete installation of electrical tramways, other than buildings.

Sections of the above undertaking are divided as follows: — Power-house equipment, steam plant; power-house equipment, electrical plant; steel stack, travelling crane, cooling tower, car-bodies, car-trucks, car motors, compressed air brakes, equipment of cars, and sundry supplies; repair shop tools, rails, fishplates, fishbolts, and special work, permanent way, overhead construction, emergency wagon, destination boxes, tablet, and staff boxes, life guards.

Brazil.

Eugenie de Andrade, the civil engineer, has been granted a decree to construct and work for seventy years an electric railway of 1·35 metres gauge from Rio de Janeiro to Petropolis.

Chile.

A concession has been granted to Messrs. Leopoldo Ottenheim and Carlos Gibbes to construct a narrow-gauge railway between the mineral district of Collahuasi and a point on the Iquique railway situated near the place known as Chalacollo. The same concessionaires have received permission to construct a carriage road suitable for automobile goods traffic between the places above-named during the construction of the railway.

Tenders, to be opened on June 28th next, are invited for the public electric lighting of the city of Punta Arenas (Straits of Magellen).

WHAT OUR TECHNICAL COLLEGES ARE DOING.

BY

A TECHNICAL STUDENT.

A NEW DEPARTURE—CENTRAL.

THE publication of a journal entitled *The Central*, marks a new phase in the history of the Old Students' Association of the Central Technical College. Judging by the first number, which has an excellent portrait of Professor W. C. Unwin, this will be a very creditable production. The editors are Mr. E. Frankland Armstrong and Mr. Maurice Solomon. It is primarily intended to publish a magazine which will be of interest to the central students, past, present, and future, the second object of the promoters being to produce a magazine which shall be worthy of the college, and which shall serve as a permanent record of the valuable work it is doing. The publication will appear two or three times a year at first, and with greater frequency afterwards if success justifies the undertaking.

OLD CENTRALIANS AND THEIR WORK.

Perhaps the most interesting feature of the magazine is the section which is devoted to the doings of old students. From this we note that no less than four Old Centralians have been appointed to the responsible positions of electrical engineers in charge of H.M. Dockyards. In wishing these gentlemen every success in their new work, it is hoped that they will at some future date furnish an account of their experiences. Mr. R. Wightman goes to the Cape of Good Hope; Mr. A. D. Constable, who held an Institute scholarship in 1892 and the John Samuel scholarship in 1894, to Bermuda; and Mr. J. S. Pringle (Electrical, 1893–6) to Malta. Mr. H. C. Leake, who gained the John Samuel Scholarship in 1892 and the Siemens Memorial Medal in 1894, and who took diplomas in both the engineering and electrical departments, goes to Devonport Dockyard.

In connection with America, says *The Central*, we may refer to the work of Mr. A. S. E. Ackermann, who was both a student and a demonstrator at the college. Mr. Ackermann recently went on a tour through the States investigating American methods of coal cutting by machinery. The results of his observations, after appearance as a series of articles, have been published in book form. He was called upon to give evidence before the Royal Commission on Coal Supplies a short time ago. Mr. Ackermann is acting energetically as secretary to the Civil and Mechanical Engineers' Society, which he has resuscitated into activity after it had been for a long time practically non-existent.

ANNUAL PRIZE DISTRIBUTION AT BRISTOL.

In the course of an excellent address on the occasion of the annual prize distribution at the Merchant Venturers' Technical College, Bristol, Sir William Mather, M.P., remarked that accommodation had been provided all over the country for a considerable amount of thorough technical training; but alas, very little thorough teaching was attempted, because it was not demanded, and little secondary education existed to prepare for it.

It was in vain that we chafed under the stress of competition, while we neglected to possess ourselves of the intellectual weapons which must be added to character, energy, manual dexterity, and large material resources, to hold the field. He would like to see a fiscal programme for education, secondary, technological and university, proposed by a government of this country, to extend over twenty-five years, with the avowed object of giving our people the same advantages of culture as the people of the three great countries, Germany, France and America, enjoy, suitable to the characteristics of our race. We had superior natural gifts and political institutions, the greatest experience, and the greatest command at the lowest price of the world's raw materials for every purpose. We must make a business of education.

PROFESSOR J. WERTHEIMER'S REPORT.

The report of the principal, Professor J. Wertheimer, B.Sc., B.A., showed that since the last annual prize distribution great changes had taken place in the equipment of the college. The laboratory and workshop accommodation had been doubled, and the governors were now in a position to offer opportunities for higher technical education which were at least as good as those obtainable in any city of the same size in the United Kingdom. The laboratories for physics, mechanical engineering and electrical engineering had been doubled in size; a large engine house had been provided, in which there would soon be placed the experimental engine which Messrs. Robey and Co., of Lincoln, were building for them, with its boiler and measuring apparatus of all kinds, as well as two new large dynamos which would be used to supply light and power for the Rosemary Street building and to afford additional opportunities for the electrical engineering students to undertake practical work on a large scale. They now had larger workshops for carpenters, plumbers, masons, bricklayers and boot and shoe makers, as well as new and well-provided shops for printers and bookbinders. All these new rooms had been equipped with the most modern machinery and tools and in accordance with the latest practice.

The college library had been made more accessible to the students by the provision of a reading room at the branch building opposite the college; a new lecture room specially equipped for electrical engineering had been provided in the main building, and two additional lecture rooms for technological classes were available in the new building in Rosemary Street.

In making these improvements, the governors had been aided by a capital grant from the Corporation of the City of Bristol; this had enabled them to complete these changes on a scale worthy of the city.

THE YORKSHIRE COLLEGE.

In order to be fully prepared to meet the responsibilities of a self-contained university, the Council of the Yorkshire College are making an endeavour to increase its capital and income, so as to give additional strength to some of its departments, and to provide sufficient class rooms and laboratories for all its work. By these means it is hoped that the county will possess a university fully equipped to meet all its requirements in matters of higher education.

It is hoped that funds will be obtained by means of private donations, which will provide the university not only with the additional accommodation which the college has long needed, and which is essential for the efficient working of the university, but also with an important accession to the present small endowments which the college possesses.

In the meantime we are glad to hear that the discussions upon the dissolution of the federal Victoria University, which have been so numerous of late, have not injuriously affected the Yorkshire College, but on the contrary have tended to give publicity to its real strength, and the hold it has upon the county in which its work has been done.

It is gratifying to note, owing to the active canvass which has been prosecuted during the year by the Mining Committee, and in particular by Mr. A. Currer Briggs, the chairman, and Mr. W. H. Pickering, H.M. Inspector of Mines, promises of donations to the fund for the building and equipment of the mining department have been received, completing the fund of £7,000, the minimum sum required for that purpose. The Council are thus placed in a position to obtain an addition to the college buildings, which has been much wanted for some years.

The college was attended by 1,191 students last session, as against 1,165 in the session preceding. The increase in the number of registered day students was five, and in the occasional and evening classes twenty-one.

THE UNIVERSITY COLLEGE, SHEFFIELD.

The prospectus of the Technical Department of University College, Sheffield, for the session 1903–4, affords an excellent idea of the important work which is being done under the ægis of Professor Ripper. The Mining Department, under Professor F. W. Hardwick, M.A., has for some years past met the needs of nearly 1,000 students, the actual number entered for instruction in 1902–3 being 966. With regard to the local classes in the West Riding, these are instructed on a syllabus drawn up some years ago by the college authorities and the Education Committee of the County Council. Last session this syllabus was introduced optionally into Derbyshire, and is now being taken by nearly half the classes in that county; previously the local mining classes in both counties were instructed on the syllabus issued by the Board of Education in subject XVIII. "Principles of Mining."

IMPORTANT DEVELOPMENTS AT BRADFORD.

During the past year the Technical Instruction Committee of Bradford have been seriously considering the question of extending their college, and some important developments may be expected shortly. Towards the close of last session a number of firms, comprising the Bradford branch of the Engineering Employers' Federation, approached the Committee with a view of obtaining special facilities for the training of their apprentices. In consultation with the head of the department, a scheme was prepared, and was approved by the Committee, whereby the employers agree to send their apprentices to the college on one afternoon per week, without loss of wages, the fees being paid by the employers. The apprentices, on their part, undertake to attend classes on two evenings weekly, for which, if a satisfactory report be obtained, the fees will also be refunded by the employers. It is estimated that about seventy apprentices from the various works in the city will attend the college in accordance with this scheme, which will come into force next session.

A sidelight on the practical use of the college is afforded by a note in the annual report of the Committee, which gives the names of forty-four students who, at the close of the last session, had passed through the department and obtained situations on leaving.

At the annual prize distribution on December 9th, the chairman, Alderman W. E. B. Priestley, was able to report that the number of students was now 1,395, an increase of nearly six hundred during the past four years.

HINTS FROM SIR THOMAS WARDLE.

In the course of an instructive address, Sir Thomas Wardle, President of the Silk Association of Great Britain and Ireland, said it was now conceded that if technical education was to be as effective and thorough as it was in America and Germany, there must be something more than primary education to precede it. He emphasised the necessity of a thoroughly good secondary education up to sixteen years of age, and commented upon the rapid extension of the college, and the crying need of money which existed for further extension and equipment, more especially in their engineering, chemistry, and dyeing departments. Industries could not now be carried on successfully by rule of thumb, as they formerly were. It was only by scientific methods of working, and utilising the most recent developments, that satisfactory progress could be made, or a remunerative business conducted. He considered that inducements ought to be provided by the State for boys of all conditions in life to continue at school long enough to be fit for technical instruction. He would like to see the immediate appointment of a Minister of Commerce of Cabinet rank, who would do great industrial service by assisting our Chambers of Commerce in examining the Patent Laws. In conclusion, he advised students not to be tempted to make short cuts at efficiency, whether by irregular attendance or by short and abnormal sessions. Sound training can only be achieved by regularity of study and work in the day classes, and by going fully through the whole course of the curriculum provided for each vocation. It is not enough to trust to evening classes if the highest competency is to be attained.

METALLURGY RESEARCH SCHOLARSHIP.

We are advised by the authorities of King's College London, W.C., that the Institution of Mining and Metallurgy Research Scholarship of £50 has been awarded by King's College, London, to Mr. R. S. Bradley. We hope to say something about Mr. Bradley's work next month.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

MARINE PETROL ENGINES AND MOTOR LAUNCHES.

IN the course of a paper on the above subject, read by Mr. O. Sumner before the Institute of Marine Engineers, the two types of marine petrol engine known as the two-cycle and the four-cycle, were contrasted. The author explained that the former had an impulse per revolution, and the latter an impulse every second revolution. Simple, reliable, and effective though the two-cycle engine might be for any practical use, it had theoretical imperfections not found in the four-cycle type. It had not a complete exhaust or scavenging stroke, and a certain residue of the burnt gases from the previous impulse must be left in the cylinder, when the top edge of the piston had closed the exhaust port. The two-cycle engine, simple as it looked, was a far more difficult engine to design than the four-cycle, owing to the fact that its two strokes must provide for the various functions for which in the four-cycle engine four strokes were provided. It was not correct, as stated by some manufacturers, that the two-cycle engine would develop twice the horse-power of a four-cycle engine of similar dimensions. It was only with a four-cycle engine that they could possibly obtain the fullest kinetic value out of the fuel, but it would strike marine engineers that the heavy blow at the moment of impulse, which must impart such energy to the comparatively very heavy flywheel as would carry it for three more strokes with no perceptible reduction in speed. entailed heavy wear and tear, and the fact that that was allowed for by giving all parts subject to the shock additional length and diameter, while mitigating, did not remove the objection. The four-cycle engine was unquestionably the engine for large craft, whilst the two-cycle engine was suitable for any class of launch up to about 50 ft.

THE HEAT TREATMENT OF STEEL.

SIXTH REPORT TO THE ALLOYS RESEARCH COMMITTEE.

AT a meeting of the Institution of Mechanical Engineers, held on the 15th ult., the sixth report of the Alloys Research Committee on the Heat Treatment of Steel was presented. It is a work of eighty-four pages packed with exceedingly valuable information, and has numerous plates, including altogether no less than 162 figures, and many photomicrographs.

The first ten pages are by the late Sir William C. Roberts-Austen, K.C.B., D.C.L., the remainder having been added by Professor William Gowland. We hope on a future occasion to deal more in detail with this report, but in the present issue are unable to find space for more than a few of the most important tables.

Eight series of bars were supplied for these experiments. The compositions of these bars were as follows :—

ANALYSES OF THE BARS BY MR. F. W. HARBORD, ROYAL INDIAN ENGINEERING COLLEGE.

	A	B	C	D	E	F	G	H
Carbon ...	0·130	0·180	0·254	0·468	0·722	0·871	0·947	1·306
Silicon ..	0·020	0·024	0·033	0·072	0·098	0·080	0·081	0·050
Sulphur ...	0·020	0·020	0·020	0·025	0·020	0·019	0·019	0·017
Phosphorus	0·011	0·022	0·025	0·016	0·015	0·019	0·013	0·015
Manganese	0·185	0·250	0·190	0·160	0·217	0·190	0·181	0·180
Arsenic ...	0·024	0·007	0·007	0·007	0·007	0·010	0·003	0·003

Tests were made on the different sets of bars as received, and after they had been subjected, respectively, to the following treatment : Annealed for half an hour at the following temperatures :—620° C. (1,148° F.), 720° C. (1,328° F.), 800° C. (1,472° F.), 900° C. (1,652° F.), 1,100° C. (2,012° F.) Soaked for twelve hours at approximately the temperatures given above.

Quenched at the following temperatures in water :—720° C. (1,328 F.), 800° C. (1,472° F.), 900° C. (1,652° F.), 1,200° C. (2,192° F.). Quenched in oil.

Rolled steel, which was the material chosen for the experiments, has, of course, relatively higher importance on account of its wide use for constructional purposes. Each test piece, after receiving its thermal treatment, had a portion of one of its ends removed for examination under the miscroscope. The bars were then mechanically tested for :—(1) Breaking stress ; (2) elastic limit ; (3) elongation ; and (4) reduction of area. Some particulars of these tests will be found on the opposite page.

THE ELECTRICAL RECONSTRUCTION OF THE SOUTH LONDON TRAMWAYS ON THE CONDUIT SYSTEM.

AT a recent meeting of the Institution of Civil Engineers, a paper was contributed by Mr. Alexander Millar, A.M.Inst.C.E., on "The Electrical Reconstruction of the South London Tramways on the Conduit System." The route length of the Tooting lines is slightly over eight miles.

Drainage of the conduit is provided for by connecting it to the sewers at intervals of sixty yards. These connections pass through a settling chamber, which intercepts the mud from passing into the sewers. The slot-rails are supported by the yokes and the track rails by an 8 in. concrete bed, and both are held to gauge by tie bars fixed to projecting lugs on the

Comparison of Breaking Stresses (in tons per square inch) of Annealed and Soaked Bars

Carbon per cent.	Original bars as received	Bars annealed for half-an-hour					Bars soaked for twelve hours			
		620° C (1148° F.)	720° C (1328° F.)	800° C (1472° F.)	900° C (1652° F.)	1100° C (2012° F.)	620° C (1148° F.)	720° C (1328° F.)	900° C (1652° F.)	1200° C (2192° F.)
0·130	30·22	—	20·16	[illegible]	21·48	—	19·75	20·60	—	—
0·180	31·52	30·60	26·52	26·46	27·84	26·91	26·91	27·75	26·91	25·27
0·254	33·25	34·50	28·80	29·40	29·46	28·11	28·60	28·18	29·55	24·80
0·468	36·96	37·02	32·82	33·00	32·46	31·38	32·01	29·31	29·91	29·10
0·722	49·00	50·22	39·96	42·48	43·20	42·38	[illegible]	38·11	43·21	40·17
0·871	58·02	55·02	43·98	52·50	50·40	47·09	45·25	39·58	49·32	29·56
0·947	53·74	52·90	39·30	39·96	51·12	49·62	45·41	53·73	47·76	24·02
1·306	56·11	51·54	50·58	39·12	44·52	46·62	46·96	33·38	44·41	35·93

Comparison of Elastic Limits (in tons per square inch) of Annealed and Soaked Bars.

Carbon per cent.	Bars annealed for half-an-hour					Bars soaked for twelve hours.			
	620° C (1148° F.)	720° C (1328° F.)	800° C (1472° F.)	900° C (1652° F.)	1100° C. (2012° F.)	620° C (1148° F.)	720° C (1328° F.)	900° C (1652° F.)	1200° C (2192° F.)
0·130	—	11·34	[illegible]	13·62	—	10·64	11·67	—	—
0·180	26·50	14·52	16·08	15·84	15·37	14·31	7·63	20·62	20·76
0·254	27·78	18·24	19·44	17·28	15·30	17·22	15·81	25·09	[illegible]
0·468	27·36	21·60	18·72	18·03	14·28	[illegible]	11·76	25·58	23·79
0·722	31·62	22·98	†	†	†	21·13	16·16	[illegible]	29·91
0·871	29·28	†	†	†	†	[illegible]	[illegible]	42·75	21·65
0·947	31·20	†	22·50	†	†	23·15	14·11	36·07	20·09
1·306	40·92	†	†	†	†	28·29	11·69	38·04	26·77

† No definite yield point.

Comparison of the Elongations per cent. on 2 inches of Annealed and Soaked Bars.

Carbon per cent.	Original bars as received	Bars annealed for half-an hour					Bars soaked for twelve hours.			
		620° C (1148° F.)	720° C (1328° F.)	800° C (1472° F.)	900° C (1652° F.)	1100° C (2012° F.)	620° C (1148° F.)	720° C (1328° F.)	900° C (1652° F.)	1200° C (2192° F.)
0·130	[illegible]	—	44·50	46·20	45·00	—	48·50	42·50	—	—
0·180	12·50	33·00	36·00	35·00	33·50	30·50	32·50	29·50	37·00	[illegible]
0·254	12·70	24·00	32·50	29·50	32·50	33·50	31·00	31·00	29·00	12·50
0·468	6·25	24·00	29·00	27·50	28·00	27·00	33·00	[illegible]	30·00	16·00
0·722	11·72	20·50	23·00	17·70	[illegible]	14·00	[illegible]	21·00	12·50	11·00
0·871	5·47	12·00	20·00	11·50	11·20	11·00	19·50	19·50	[illegible]	20·00
0·947	7·03	15·00	22·00	[illegible]	10·00	7·50	18·50	23·50	11·00	20·00
1·306	7·03	*3·00	7·00	20·00	5·50	6·50	11·50	26·50	10·00	33·00

* Broke outside gauge points.

Comparison of the Reductions of Area at Fracture (in Percentages) of Annealed and Soaked Bars.

Carbon per cent.	Original bars as received	Bars annealed for half-an hour.					Bars soaked for twelve hours.			
		620° C (1148° F.)	720° C. (1328° F.)	800° C (1472° F.)	900° C. (1652° F.)	1100° C (2012° F.)	620° C (1148° F.)	720° C (1328° F.)	900° C (1652° F.)	1200° C (2192° F.)
0·130	34·73	—	73·20	71·16	71·16	—	91·12	73·21	—	—
0·180	29·71	62·85	72·54	67·32	60·24	60·60	71·43	61·11	58·80	[illegible]
0·254	25·31	55·06	62·66	58·56	54·84	54·77	65·18	57·28	57·50	[illegible]
0·468	18·76	49·70	58·56	45·90	46·26	40·38	57·61	42·70	43·50	28·60
0·722	3·43	33·48	47·88	31·74	25·86	17·21	46·54	35·97	14·00	11·30
0·871	5·88	22·11	40·42	16·92	15·64	12·51	39·82	[illegible]	15·90	40·20
0·947	5·63	27·00	45·00	28·44	15·42	9·07	27·10	35·44	11·00	37·50
1·306	8·48	3·90	5·12	53·90	5·58	8·94	16·45	34·50	11·70	21·70

Comparison of Breaking Stresses (in tons per square inch) of Bars Quenched in Water and in Oil

Carbon per cent.	Original bars as received.	Quenched in Water at 20° C (68° F.)				Quenched in Oil at 80° C (176° F.)					
						Not tempered.	Tempered at 350° C (662° F.)			Tempered at 600° C (1112° F.)	
		720° C (1328° F.)	800° C (1472° F.)	900° C. (1652° F.)	1200° C. (2192° F.)	720° C (1328° F.)	720° C (1328° F.)	870° C (1598° F.)	1000° C (1832° F.)	800° C (1472° F.)	900° C (1652° F.)
0·130	30·22	56·18	38·88	32·34	44·29	32·68	22·13	24·50	[illegible]	21·42	24·55
0·180	31·52	44·82	49·62	49·92	72·78	46·79	31·10	36·12	35·90	36·16	30·13
0·254	33·25	43·20	62·38	70·32	77·04	37·54	34·15	41·13	46·32	—	31·24
0·468	36·96	39·90	61·26	55·44	31·74	39·75	41·63	54·55	[illegible]	41·06	[illegible]
0·722	49·00	51·00	*	51·96	13·44	50·43	48·70	78·59	76·41	56·47	50·44
0·871	58·02	54·84	*	26·04	5·40	76·77	53·94	90·68	53·34	[illegible]	52·55
0·947	53·74	56·04	*	21·60	4·30	52·30	54·63	102·52	54·19	45·97	49·10
1·306	56·11	56·94	70·02	*	3·52	23·82	57·75	90·57	[illegible]	46·86	51·32

* Broke in clips.

Comparison of Elastic Limits (in tons per square inch) of Bars Quenched in Water and in Oil.

Carbon per cent.	"Normalised" Bars Annealed at 620° C (1148° F.)	Quenched in Water at 20° C. (68° F.)				Quenched in Oil at 80° C (176° F.)					
						Not tempered.	Tempered at 350° C (662° F.)			Tempered at 600° C (1112° F.)	
		720° C (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1200° C. (2192° F.)	720° C (1328° F.)	720° C (1328° F.)	870° C (1598° F.)	1000° C (1832° F.)	800° C. (1472° F.)	900° C. (1652° F.)
0·130	—	*	†	24·30	†	18·67	[illegible]	15·69	19·62	14·78	15·62
0·180	26·50	*	†	*	†	[illegible]	16·83	23·81	23·42	29·82	24·56
0·254	27·78	†	*	*	†	[illegible]	22·56	28·81	25·29	—	25·86
0·468	27·36	†	*	*	†	29·14	25·43	42·52	37·24	31·92	29·02
0·722	31·68	†	*	†	†	30·74	27·47	36·54	50·96	49·20	44·63
0·871	29·28	*	*	†		[illegible]	27·38	57·55	58·30	46·86	46·85
0·947	34·20	*	*	*	*	40·00	39·32	49·23	48·13	35·70	40·18
1·306	[illegible]	†	†	*	*	37·75	40·13	56·28	56·81	42·50	42·40

* Broke in clips. † No definite yield point.

Comparison of the Elongations (per cent. on 2 inches) of Bars Quenched in Water and in Oil

Carbon per cent.	Original bars as received	Quenched in Water at 20° C (68° F.)				Quenched in Oil at 80° C (176° F.)					
						Not tempered.	Tempered at 350° C (662° F.)			Tempered at 600° C. (1112° F.)	
		720° C (1328° F.)	800° C (1472° F.)	900° C (1652° F.)	1200° C (2192° F.)	720° C (1328° F.)	720° C (1328° F.)	870° C (1598° F.)	1000° C (1832° F.)	800° C (1472° F.)	900° C. (1652° F.)
0·130	20·00	23·00	21·70	28·20	3·00	29·00	41·00	39·50	32·50	38·00	40·70
0·180	12·50	14·00	14·50	8·50	[illegible]	25·00	29·00	23·50	26·50	26·00	[illegible]
0·254	12·70	13·70	6·50	3·00	[illegible]	23·00	25·00	24·50	[illegible]	—	[illegible]
0·468	6·25	21·00	[illegible]	1·00	Nil	[illegible]	[illegible]	[illegible]	14·00	17·00	27·20
0·722	11·72	17·50	*	1·00	Nil	18·50	21·50	23·50	14·00	17·50	17·50
0·871	5·47	15·80	*	2·00	Nil	13·00	13·50	10·50	[illegible]	15·00	15·50
0·947	7·03	[illegible]	*	Nil	Nil	13·00	12·00	7·00	5·50	12·00	17·00
1·306	7·03	8·80	[illegible]	—	Nil	7·00	6·50	5·50	5·00	7·50	17·60

* Broke in clips.

Comparison of the Reductions of Area at Fracture (in Percentages) of Bars Quenched in Water and in Oils.

Carbon per cent.	Original bars as received.	Quenched in Water at 20° C (68° F.)				Quenched in Oil at 80° C (176° F.)					
						Not tempered.	Tempered at 350° C (662° F.)			Tempered at 600° C (1112° F.)	
		720° C (1328° F.)	800° C. (1472° F.)	900° C (1652° F.)	1200° C (2192° F.)	720° C (1328° F.)	720° C (1328° F.)	870° C (1598° F.)	1000° C. (1832° F.)	800° C (1472° F.)	900° C (1652° F.)
0·130	34·73	60·20	59·94	76·26	39·12	[illegible]	75·91	75·44	[illegible]	[illegible]	[illegible]
0·180	29·71	46·92	51·60	35·28	5·15	60·24	59·48	[illegible]	[illegible]	[illegible]	[illegible]
0·254	25·31	45·96	8·94	13·44	4·74	57·77	57·87	[illegible]	[illegible]	—	[illegible]
0·468	18·76	48·78	6·00	2·54	Nil.	48·82	50·12	47·17	63·59	[illegible]	[illegible]
0·722	3·43	32·92	*	2·58	Nil	36·54	36·00	[illegible]	[illegible]	[illegible]	35·50
0·871	5·38	29·58	*	2·16	Nil	[illegible]	27·63	[illegible]	[illegible]	[illegible]	[illegible]
0·947	5·63	21·78	*	Nil	Nil	19·31	18·64	[illegible]	14·84	[illegible]	[illegible]
1·306	8·48	15·34	1·32	*	Nil.	8·67	—	[illegible]	[illegible]	[illegible]	21·00

* Broke in clips. † Broke outside gauge points.

TABULATIONS FROM THE SIXTH REPORT OF THE ALLOY'S RESEARCH COMMITTEE.

yoke head. At junctions and crossings steel castings take the place of the rolled rails, and specially-wide yokes are used to embrace the converging conduits, and to support the track rails as well as the slot rails. The mechanism for operating the slot and track points at junctions is contained in a concrete pit built immediately underneath the track. Both track points are fitted with 8 foot movable tongues, which are connected together to the slot leaves by a series of cranks and adjustable links, so that the whole can be moved in unison by inserting and manipulating a lever either in a box in the footpath, or alongside the track. The free end of the slot leaves is bevelled off, so that a car trailing through can push over the points without any external assistance. A feature about the work is that at no part is the slot wider than ¾ in.

GRINDING MACHINERY AND ABRASIVE WHEELS.

THIS was the subject of a paper read by Mr. Keith C. Bales, at a meeting of the Institution of Marine Engineers. The paper dealt in detail with the various forms of grinding tools, and gave examples of the work they are capable of doing.

Although the grinding machine has been in use for a number of years, it was, he said, of comparatively modern introduction, especially in machine shops on general work, but it was becoming an indispensable tool in up-to-date works. It had been proved beyond dispute that the lathe was incapable of producing accurate work, even in soft metal, and altogether failed when called to operate upon hard metals. With the grinding machine, however, the same degree of accuracy could be obtained whether the metal being ground was soft, such as copper and its alloys, or hardened steel and chilled rolls. The economy of grinding for finishing work was proved by the fact that emery or other abrasive wheels, to grind a given amount of work, cost less than files, oil, and emery cloth, and reduced the time of production, besides giving accuracy, which, being incidental to the process, cost nothing. The most important part of the grinding machine was, of course, the grinding wheels, and those had two distinguishing characteristics, either or both of which might be varied according to the class of work to be done. Emery used in the manufacture of the wheels was found in the form of rock and was crushed into various grades of fineness. Another substance of which abrasive wheels were partly made was corundum, a mineral similar to emery. Corundum was becoming scarce, and carborundum, a manufactured substance, was now largely used. The component parts of carborundum were coke, sand, and salt, fused by the electric arc.

Mr. James Howie, who opened the discussion on the subject, said he had rather a fear as to the abrasive wheels bursting, and he thought the speed mentioned was a terrific speed at which to drive them. He would like to know if Mr. Bales had had any experience of wheels bursting. Manufacturers were rather diffident about installing those machines for heavy work, but they were all right for finer work.

Mr. F. Cooper said it was a matter of controversy whether it were better to move the work or the wheel. Some emery wheels now made were fitted with wire, and it was claimed for them that they were perfectly safe and almost unburstable. He believed the best makers tested all their wheels at a certain speed in wooden cases, so that the man who performed the test could not be injured if the wheel burst. That man had to go before a Justice of the Peace and swear that he had tested that particular wheel at a certain speed. The wheels were, as a rule, tested to about twice their running speed.

Mr. S. C. Sage said he had been over a factory in Holland where they made marine engines for war vessels, and they told him that all their piston-rods for all kinds of engines were ground up after passing through the lathe. He saw the operation being carried through. Every piston-rod and the valve spindles were ground up, and they were also grinding the reversing links. Holes were lapped, and every cast-hardened surface was ground up after being hardened. The grinding machines came originally from America, but on the Continent, especially in France and Germany, they had adopted them more than we had hitherto.

Mr. Bales then furnished some lengthy particulars as to the comparative times of production in finishing lathe mandrils or spindles in the lathe and by the use of the grinding machine, from which it appeared that, besides the saving obtained in finishing by grinding, much more accurate work was produced. They had heard it stated that grinding machines were in use in Holland and America, and he wanted to know why they should not have them in this country.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the ordinary meeting on Tuesday, the 22nd December, 1903, Sir William H. White, K.C.B., President, in the chair, the Paper read was "On the Resistance of Plane Surfaces in a Uniform Current of Air," by T. E. Stanton, D.Sc., Assoc.M.Inst.C.E.

The paper deals with the results of experiments made in the Engineering Department of the National Physical Laboratory on the distribution and intensity of the pressure on thin plates and combinations of plates placed in a uniform current of air, and is intended as the first part of a research on the nature and distribution of the pressure of the wind on structures. By a uniform current of air is meant a current in what is known as "eddying motion" as distinguished from stream-line motion, the mean velocity at any point in the direction of flow being uniform across the current. This condition of motion is considered to be the nearest approximation to that of winds of fairly high intensity. The main object of the present research was to determine, if possible, a general relation between the velocity of the current, the dimensions of the plates, and the resultant pressure, as it was felt that experiments in the open air could not be undertaken with any prospect of success until some general relation of the kind had been established. The results of the experiments show that, under the given experimental conditions, a definite relation of the kind existed and may be stated thus: For similar and similarly situated plates or combinations of plates in a uniform current of air, the intensity of pressure is the same for the same velocity of current and general atmospheric conditions. On the assumption that the motion of the wind approximates to that of a uniform current as defined above, the above relation shows that the distribution and intensity of the pressure of the wind on structures may be studied experimentally by means of models of the structures set up in a current of air produced by means of a fan, as in the present case. In illustration of this, the results of experiments made on models of roofs and lattice girders of simple form are given in the paper.

Tabulated results are also given for the cases of parallel plates at varying distances apart, plates inclined at varying angles to the direction of the current, and rectangular plates of varying ratio of length to width.

THE KOLAR GOLD FIELD.

IN a paper contributed to the Institution of Mining and Metallurgy, Mr. A. Mervyn Smith brought the geology of the Kolar Goldfield up to date.

A RICH YIELD.

The Kolar Goldfield, though one of the smallest in the world in point of area, is one of the richest—if not the richest—in point of gold production. Up to September last it had yielded no less than sixteen millions sterling in gold, of which six millions has been paid away in dividends to shareholders, while the annual output has now reached the large total of two and a quarter millions sterling. The industry at the same time gives employment to some twenty thousand mining men, hundreds of whom are miners from this country, and some of them members of this institution. The question how long this flourishing state of things may be expected to continue is one of great importance.

SOME CHARACTERISTICS.

On the geological map, published by the Government of India (December, 1892), fifty thousand square miles of surface are marked as covered by gold-bearing rocks, known as the Dharwar series of India. Three great areas of these rocks are shown, occurring at wide intervals from each other. One of these is in South India, another in Bengal, and a third in Central India. All of them show signs of extensive denudation in the numerous outlying little patches of auriferous rock, which were at one time part of the big areas.

The Kolar Goldfield is one of a number of such small patches fringing the southern border of the Dharwar rocks of South India. It is some forty miles long from north to south, and from three-quarters of a mile to four miles wide from east to west.

The Kolar goldfield may be briefly described as a narrow band of schistose rocks surrounded by granite. Quartz reefs occur in the granite as well as in the schistose rocks, but only those in the schistose band have been proved to be auriferous. This schistose band stretches north and south a distance of forty miles, and has a varying width of from one to four miles. The "strike" of the foliation of these schistose rocks (known in Indian geology as the "Dharwars") is generally north and south, though, owing probably to lateral pressure, due to intrusions of the newer granites, the line is somewhat sinuous.

The reefs on the Kolar field fold back on themselves in many places. This is particularly noticeable in the case of the Champion lode on the Mysore, Champion Reefs, and Nundydroog properties. Where these folds come to the surface, three parallel lodes are seen near to each other, and extending sometimes a length of 200 ft. along the strike of the country, north and south. These folds have a pitch-north at an angle of about 45°.

Another feature that plays an important part in all questions of development is the occurrence of numerous large dykes of acid and basic rocks. Many hundreds of dolerite dykes may be seen cutting across the schist belt from east to west, and a few from north to south. Those running north and south are larger and more marked than the others. It is thought that these basic dykes are younger than any of the other rocks seen on the Kolar goldfield, as they traverse indiscriminately the surrounding granito-gneiss as well as the schists.

GENERAL CONCLUSIONS.

Veins of pegmatite also cut across the schists from the east to west, and dislocate the quartz lodes. Mr. Bosworth Smith believes they also cut through the dolerite dykes. If this is the case, then they must be younger than the basic dykes.

To summarise, then, it may be said that all observers who have written on the geology of this field are agreed :—

(1) That the auriferous rocks form a narrow band, from one to four miles wide, from east to west and some forty miles long.

(2) That the auriferous rocks are bent into a synclinal fold, with a north and south axis.

(3) That the auriferous quartz reefs occur about the middle of the schist band and are parallel to the layers of the schist, and hence strike north and south.

(4) That the Champion lode, which occurs on the east central portion of the belt, dips west at an angle of from 45° to 60°. Probably the average dip is about 45°, and this seems to be the opinion of the managers of the Mysore Mine who expect to cut the reef at a depth of 2,000 ft. in a vertical shaft (Edgar shaft) sunk 2,000 ft. west of the outcrop.

If, then, one set of geologists are correct in their conclusions, it follows that the reefs met with in the Kolar goldfield cannot go deeper than the synclinal; and as the Champion lode occurs about the middle of the schist band, and as its dip is coincident with the bedding of the schists (an angle of 45°), it is clear that it will not extend downwards in depth indefinitely.

IMPROVEMENTS ON THE PARIS UNDERGROUND RAILWAY.

OUR readers will remember the panic and disastrous loss of life which followed the serious fire on the electric trains of the Metropolitan Railway, Paris, some months ago. It is now interesting to learn that the officials of the Paris Metropolitan Railway have decided to abandon the use of power cables carrying large high tension currents through the train, and have awarded a contract to the French Westinghouse Company for the supply of 100 complete equipments of their electro-pneumatic turret type control apparatus to replace the present system. One of the chief features of the electro-pneumatic control system is that compressed air is employed instead of high tension current for actuating the controllers on all motor cars, and that the control is effected by very low currents in wires throughout the train at the harmless pressure of 14 volts.

After a very careful study of all available systems, the engineers of the Paris Metropolitan have adopted the Westinghouse apparatus because it entails by far the least fire risk, and has many other points of superiority both from the point of view of safety and satisfactory operation. Londoners will be interested to know that one of our London railways has set the pace, and that Paris is following the example of the Metropolitan Railway (London), which adopted the Westinghouse system for the operation of their trains nearly a year ago.

BOOKS OF THE MONTH.

"BRITISH INDUSTRIES."

A Series of general Reviews for Business Men and Students. Edited by W. J. Ashley, M.A., Professor of Commerce in the University of Birmingham. Longmans, Green and Co. 5s. 6d. net.

In this volume ten lectures are included which should be of material value to business men. They were written before the fiscal question became acute, and some of the contributors take one side, some another. Mr. S. S. Jeans, editor of the *Iron and Coal Trades Review*, leads off with an instructive paper on The British Iron and Steel Industries, and other items likely to be of special interest to our readers include "The Midland Iron and Steel Wages Board," by Mr. Daniel Jones, J.P.; "British Railways as Business Enterprises," by Mr. Charles H. Grinling; "British Shipping and its Present Position"; by Mr. B. W. Ginsburg, LL.D. and "The Trust Movement in Great Britain." by Mr. H. W. Macrosty.

"STRENGTH AND ELASTICITY OF STRUCTURAL MEMBERS."

By R. J. Woods, M.E., M.Inst.C.E. Edward Arnold. 10s. 6d. net.

Intended originally for the students of the Royal Indian Engineering College at Cooper's Hill, these lectures are now available to a wider circle, and are presented with numerous diagrams and illustrations, which should prove of the utmost value. Suitable examples are given to enable the student to test his adequate comprehension of the principles explained in the various chapters, which are as follows: Graphic Statics, Stress and Strain, Stress-strain Diagrams, Working Stress, Resilience, Compound Stresses, Bending Moments and Shearing Forces, Moments of Inertia, Girders, Deflections of Beams, Bending and Direct Stress, Non-axial Loads, Stress at a Plane Joint, Masonry Structures, Columns and Struts, Riveted Joints, Continuous Girders, Cantilever Bridges, Suspension Bridges, Arched Ribs, Torsion.

"ENGINE TESTS AND BOILER EFFICIENCIES."

By J. Buchetti, some time Professor at the Central Technical School, Paris. Translated and edited from the Third Edition by Alexander Russell, M.I.E.E. Constable and Co., Ltd. 10s. 6d. net.

This careful translation of Buchetti's standard "Guide pour l'essai des moteurs" has been undertaken in order to give English and American engineers an opportunity of comparing the best Continental practice with that in use in their own countries. The author mentions that he has made numerous additions to the third addition of the work, notably in those parts which are concerned with the theory of indicators, the analysis of the working of their various parts, the description of the new apparatus, such as indicators, with exterior springs for use with high-pressure engines, or when the steam has been superheated, explosion recorders for gas, petrol or alcohol engines, apparatus for reducing the scale of the reciprocating motion and the methods of setting it up, apparatus for verifying the flexibility of the springs of the indicators, etc. He has also made some additions to the chapters on brakes. The work has many excellent diagrams.

"GEOMETRY FOR TECHNICAL STUDENTS."

By E. H. Sprague, A.M.Inst.C.E. Crosby, Lockwood and Son. 1s. net.

A small book, which should be of much value to the student of engineering. The author treats with his subject in about sixty pages, but nothing of an essential nature is omitted; his explanations are concise and explicit, and the many diagrams serve to simplify the propositions.

"THE PRACTICAL ELECTRICIAN'S POCKET BOOK AND DIARY, 1904."

Edited by H. T. Crewe, M.I.Mech.E. S. Rendell and Co. and Dawbarn and Ward. 1s. net.

This handy little book is now in its sixth year of publication. The present issue has been carefully revised, but in carrying out the revision the editor has kept in view the original design, to maintain explanatory and advisory remarks on various matters in the simplest form possible. It is compact and well illustrated, and should be a very welcome companion to every practical electrician.

"THE 'DAILY MAIL' YEAR-BOOK, 1904."

Edited by Percy L. Parker. The Amalgamated Press, Ltd. 1s. 6d. net.

The "Daily Mail" Year-Book for the present year is considerably larger than previous issues. A number of new features have been added, amongst which we notice brief articles on "Steam Turbines and Speed," "Conquering the Air," "The Motor Car," "How to Obtain a Patent," "Progress of Wireless Telegraphy," etc. An admirably arranged index enhances the value of this popular work of reference.

"ELECTRICAL ENGINEERING."

An Elementary Text-book. By E. Rosenberg. Translated by W. W. Haldane Gee, B.Sc., A.M.I.E.E., and Carl Kinzbrunner. Harper and Brothers.

This treatise, written by an electrical engineer and from an engineering point of view, is based on a number of lectures delivered to the workmen and staff of a large electrical manufacturing firm, and should be extremely useful to elementary students. The idea appears to have been to present the subject in the easiest possible language; though this, of course, has necessarily involved a much larger outlay of space than would otherwise have been required. The work has a wide range, including typical dynamos and motors, accumulators and their apparatus, measuring instruments and electric light. It differs from others of an elementary character, in the space that is given to alternating current electrical engineering. The machinery illustrated is mostly German.

Owing to pressure on our space, a number of book notices are unavoidably held over.

OUR DIARY.

December, 1903.

21st.—The Legislative Council decides to appoint a commission to enquire into the whole question of Asiatic trading in the Transvaal.

22nd. — The Parisian Press Association award 60,000 fr. to Madame Curie for the continuation of her researches into radium, and 40,000 fr. to M. Branly for his labours in connection with wireless telegraphy. The L.C.C. authorises the expenditure of £90,000 for the electrification on the conduit system of the tramway between Kennington and Streatham.

23rd. — The *Times*' Johannesburg correspondent reports that not only has the Transvaal revenue received a great set-back, so that there will probably be a serious deficit at the end of the financial year, but as regards labour, the country has failed to reach a return to the conditions of things existing in 1898.

24th.—Issue of the first part of the Indian Irrigation Commission report. The Commissioners are of the opinion that the whole of India can never be protected against famine by irrigation alone, but irrigation can do much to restrict the area and mitigate the intensity of famine.—It is reported that Sir A. Jones's recent visit to Belgium has not been successful in securing a continuance of the present service of English steamers from Antwerp to Boma.

28th.—Death of Sir William Allan.—The debate on the Chinese labour question begins in the Legislative Council at Pretoria.

29th.—Issue of a Parliamentary paper showing the aggregate naval expenditure, revenue, tonnage of mercantile marine, imports and exports of all the principal countries of the world in the year 1902.

30th.—The Argentine warships, recently reported to have been sold to an unnamed purchaser, have, it is now announced, been bought by the Japanese Government.—Launch of the *Erthogroal*, a yacht for the Sultan of Turkey, at Elswick. — Appalling fire in a Chicago theatre.

January, 1904.

3rd.—It is definitely ascertained that the total number of those who lost their lives in the Chicago Theatre fire was 587.

4th.—Opening of a new railway line in Yorkshire between the Midland Station, Leeds, and Robin Hood.

5th.—Sir Oliver Lodge lectures in Birmingham on radium.

6th.—Draft ordinance to regulate the introduction into the Transvaal of unskilled, non-European labourers published in Pretoria. It provides that the introduction of Chinese labourers shall be permissible only under licences granted by the Government, with the express stipulation that they shall be restricted to the exploitation of minerals.

7th.—A boiler explosion on board the third-class cruiser *Wallaroo* causes a number of deaths and injuries. Fatal explosion at St. Helen's Colliery, Workington, caused by a miner firing a shot in the face of the main band.

8th.—The mail steamer *Clallam* founders off Smith Island, Victoria—about fifty lives lost.

9th.—Last day of the conference of teachers and others interested in the work of secondary schools and technical institutes, held under arrangements made by the Technical Education Board of the London County Council.

11th.—Mr. Seddon invites the Premiers of the Australian Commonwealth, Canada, Cape Colony, and Natal to unite in sending a protest to the Imperial Government against the introduction of Chinese into the Rand mines. —A special delegate conference of the South Wales Miners' Federation, convened to consider the distress caused by the stoppage of many collieries owing to the coal tax, unanimously adopt a resolution protesting against the renewal of the scheme in the coalfield for contracting-out of the Workmen's Compensation Act.

12th.—The electrification has been completed of a further section of London County Council's tramways namely, the lines extending from St. George's Circus to New Cross and Greenwich.

13th.—The Governments of Canada and Natal refuse to join in Mr. Seddon's protest against the introduction of Chinese labour into the Transvaal.—Private inspection of the completed works of the new "tube" railway.—Destructive firing of a gas main in Piccadilly.

14th.—Sir Douglas Fox, at a meeting of the London Traffic Commission, expresses himself in favour of the constitution of a new and permanent tribunal for dealing with railway and tramway schemes in the metropolitan area.

15th.—Announcement that electro-gas signalling plant is shortly to come into operation on the main line of the North-Eastern Railway Company.—A special committee of the Institution of Mechanical Engineers present final report dealing with the study of steel alloys.

17th.—The bursting of a reservoir causes loss of life and great destruction of property in Bloemfontein.

18th.—An important convention of the United Mine Workers of America opens at Indianapolis.—The officials of the Paris Underground Railway decide in favour of electro-pneumatic turret type control apparatus.

19th.—The Secretary for Scotland receives a deputation of Scottish scientific societies, who urge that the Royal Institution in Edinburgh should be exclusively devoted to scientific purposes.

20th.—Lord Milner, at Krugersdorp, receives a deputation of farmers, whom he addresses on the subjects of agriculture and the importation of Chinese labour. He says the revenue is declining because the principal industry of the country is working at only half its strength.

CALENDARS, NEW CATALOGUES AND TRADE PUBLICATIONS.

The Brush Electrical Engineering Company, Ltd., have issued an artistic desk calendar, the monthly sections of which are enclosed in an embossed linen-covered frame with foliated design.

The United States Metallic Packing Company send us a good practical calendar with tear-off dates nearly 3 in. in length—a boon to the short-sighted and a constant reminder of their telegraphic addresses, etc.

Messrs. Partridge and Cooper issue a calendar in twelve sections, approximately 6 in. by 8 in. Its chief merit is clearness of typography and arrangement. They also send a useful sheet calendar suitable for hanging on the wall. Each section presents not only the days of a particular month, but also a calendar of the entire year.

Messrs. Henry Good and Son, of 12, Moorgate Street, E.C., forward a neat desk calendar, the monthly sections of which are attached to an embossed blue and gilt card.

Considerable pains have been taken by Messrs. W. T. Glover and Co., Ltd., to make their second annual tear-off sheet calendar useful to professional men. The reading matter is mostly compiled from the Proceedings of the Institution of Electrical Engineers and the Incorporated Municipal Electrical Association. Photographs of prominent electrical engineers are included, and on the back of the calendar appears some data likely to be required for everyday use.

J. F. Bennet.—A calendar issued by this firm has a novel arrangement by which, instead of tearing away the dates in rotation, an adjustable sliding frame brings the dates consecutively into prominence.

A useful sheet calendar also reaches us from Messrs. Henry Good and Son, of 12, Moorgate Street, E.C.

Messrs. M. Glover and Co. are calling attention to their specialities by means of a circular glass paper-weight. This is a handy arrangement which is not likely to be thrown away.

Mr. E. Arnold Pochin, specialist in gearing and gear cutting, has included some useful technical information in his wall calendar, the dates of which, printed in red and black, stand out in bold relief.

Messrs. Walter Johnson and Co., Ltd., of 67 and 68, King William Street, E.C., forward a comprehensive wall calendar, the sheets of which are effectively printed in three colours.

Messrs. British Steam Specialities, Ltd., forward a leather-bound pocket diary. In addition to calendar and space for memoranda each day, the diary has a quantity of useful information—postal, engineering, and general.

Messrs. C. W. Hunt Company, West New Brighton, New York.—Pamphlet No. 037 gives an excellent idea in brief of their steeple powers, Parabolic boom towers, Hunt elevators, overhead trolleys, coal tubs, automatic railways, cable railways, etc.

British Thomson-Houston Company, Ltd.—Pamphlet No. 163 describes and illustrates the B. T. H. Edison incandescent lamps, and supersedes No. 135, issued December, 1902. It can with advantage be filed for reference. The latest information regarding their Multiple Unit System of Train Control for Electric Railways is compressed in a twenty-four page booklet, which shows the system in use in various parts of the world. The company have been well advised to bind these attractive sheets in a stiff cloth cover.

The Bullock Electric Manufacturing Company send us a well-printed list of their type "B" motors and generators, with illustrations and tables of ratings.

The Oliver Typewriter Company are issuing their calendar in the form of monthly postcards, which, judging from No. 1, will be worthy of careful preservation. The series will be entitled "The Art of Writing through the Century," the January calendar commencing with cuneiform inscriptions. These cards are calculated to make a cheerful addition to the paraphernalia of the desk, and will be especially welcomed by the collector of pictorial postcards.

Messrs. Walter Judd, Ltd., Advertising Contractors, have issued a striking sheet calendar in red, white, and blue. The days of the week are clearly indicated in white on a blue ground, and the dates are also thrown into strong relief, while each month's instalment of the calendar presents a view in brief of the entire year. An excellent effect is obtained by enclosing the calendar in a red border.

The Wilber H. Murray Manufacturing Company, Cleveland, Ohio, U.S.A.—An attractive catalogue of the well-known "Murray" Vehicles, comprising carriages, phætons, omnibuses, trade vehicles, harness, etc. The cover is of elegant design, and is in the form of a long strip which folds over the outside edges of the catalogue to which it is attached by a brown silk cord.

Tangyes, Ltd., Cornwall Works, Birmingham.—Catalogue No. 60, well printed and illustrated, supersedes all former lists of steam engines. The following is a synopsis of contents: Horizontal, "Colonial," "Soho," Vertical and "Archer" Steam Engines, Cross Compound Steam Engine, Tandem Compound Steam Engine, Compound "Archer" Steam Engine, Sundries for Engines, Examples. A price list of unrevised machinery at present in stock is also issued by this firm. An introductory note informs us that the machinery specified in this list is, for the most part, an accumulation consequent upon the complete revision of the manufactures of Tangyes, Ltd. In almost every case, the articles are of Tangyes' manufacture, the few exceptions being specially mentioned.

Messrs. Mellowes and Co., Ltd., Sheffield and London, issue a catalogue printed on art paper, with some exceptionally good illustrations of their "Eclipse" roof glazing. From the first of these we note that 100,000 superficial feet of this glazing was used on the Central Transept of the Crystal Palace in 1899-1900.

Messrs. H. J. H. King and Co., Newmarket Engineering Works, Nailsworth, Gloucestershire, send a quantity of information relating to their patent clutches (King's Patents), including illustrations, tables, prices, weights and sizes in cases. The second part of the catalogue is devoted to turbine, turbine governors, steam engines, etc.

J. Parkinson and Son, Canal Iron Works, Shipley, Yorks—In sending seasonable greetings for 1904, this firm recommend as a motto for the year "Efficient Equipment," and in connection therewith illustrate their "Perfect" vice, and slogging or high-speed lathe.

Messrs. R. Waygood and Co., Ltd., Falmouth Road, London, S.E.—Those who are in search of points on the electric lift cannot do better than obtain a small pamphlet which has been issued by this firm. It deals adequately with the Vee Sheave Drive drum driving for passenger lifts, American experience, the duration of ropes, etc.

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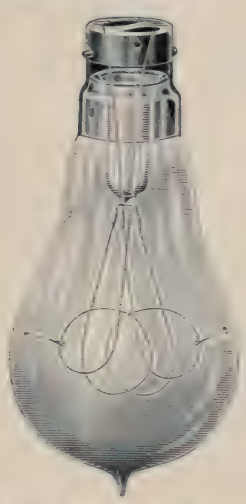

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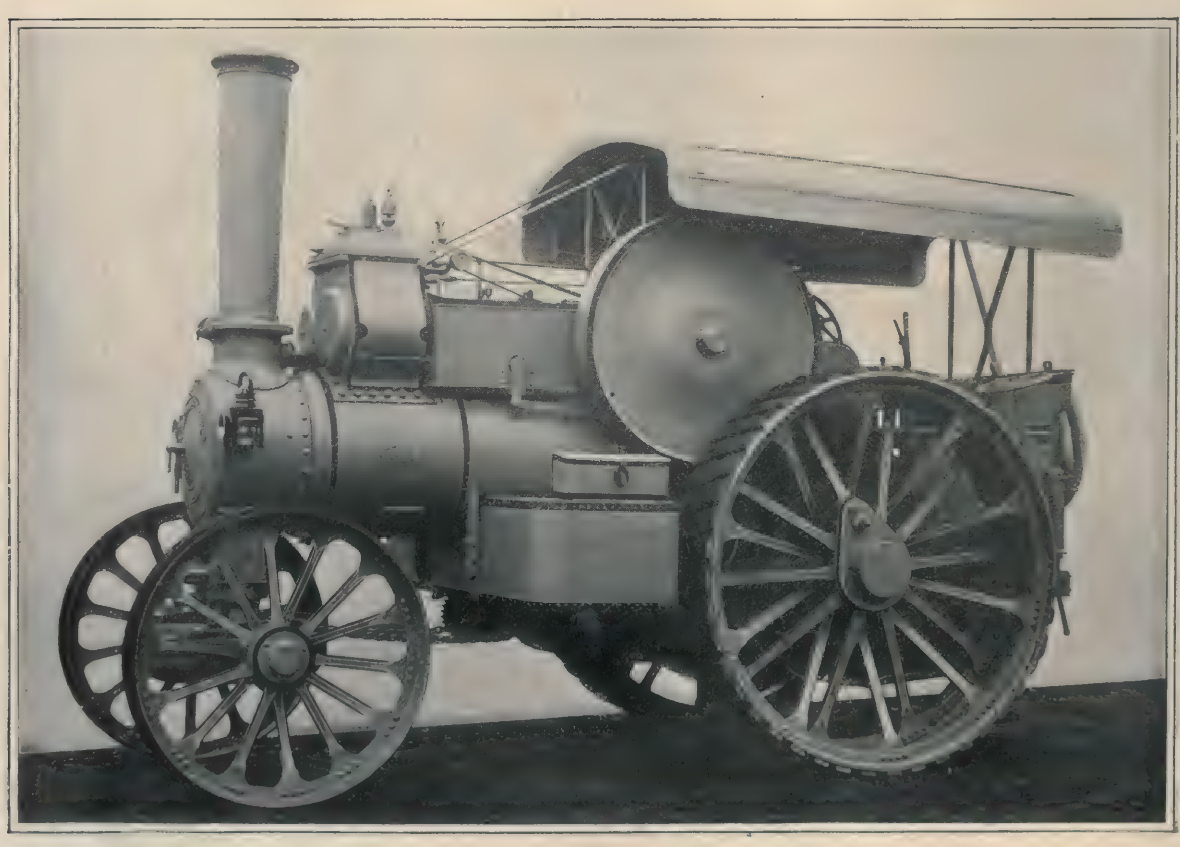

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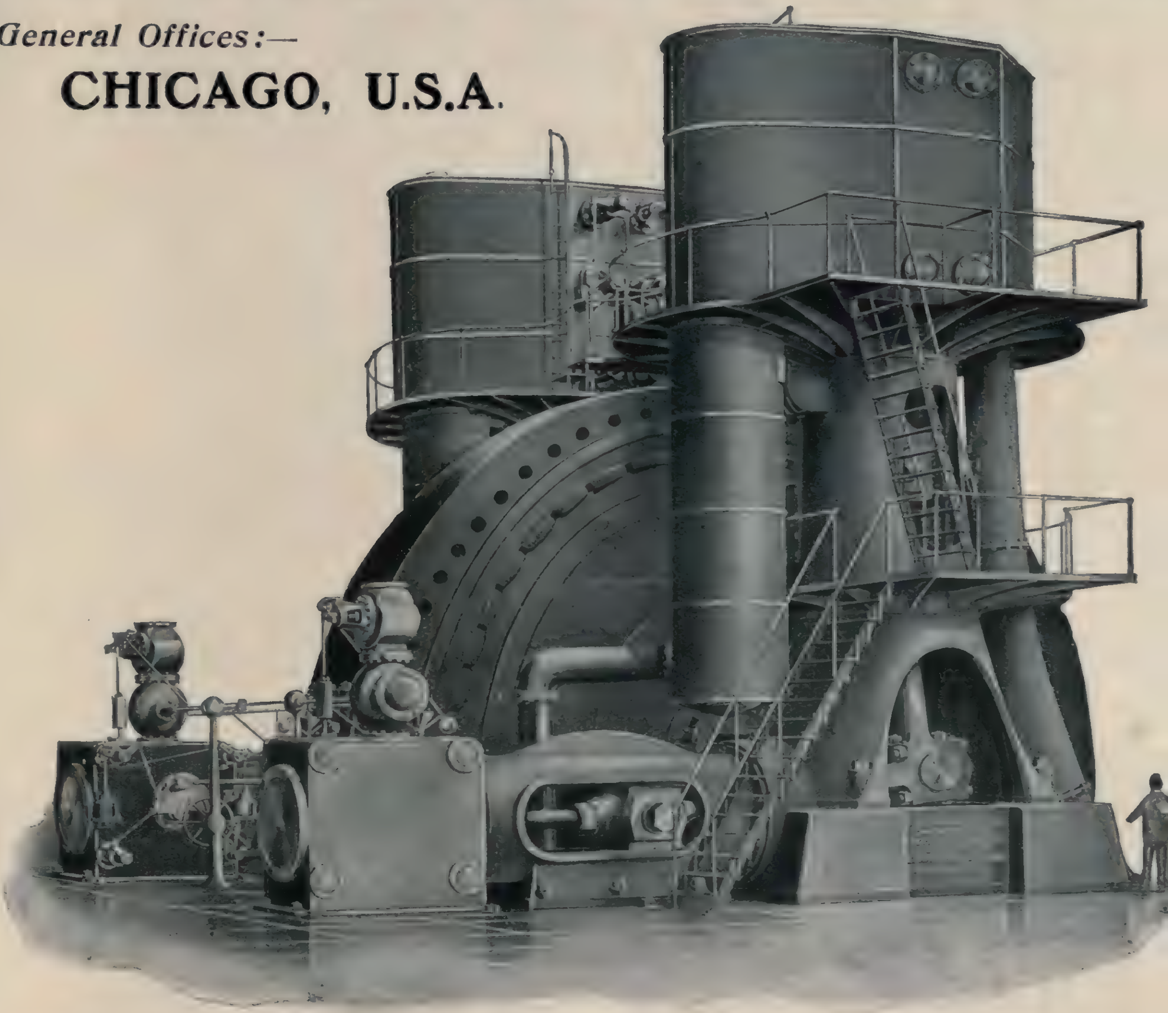

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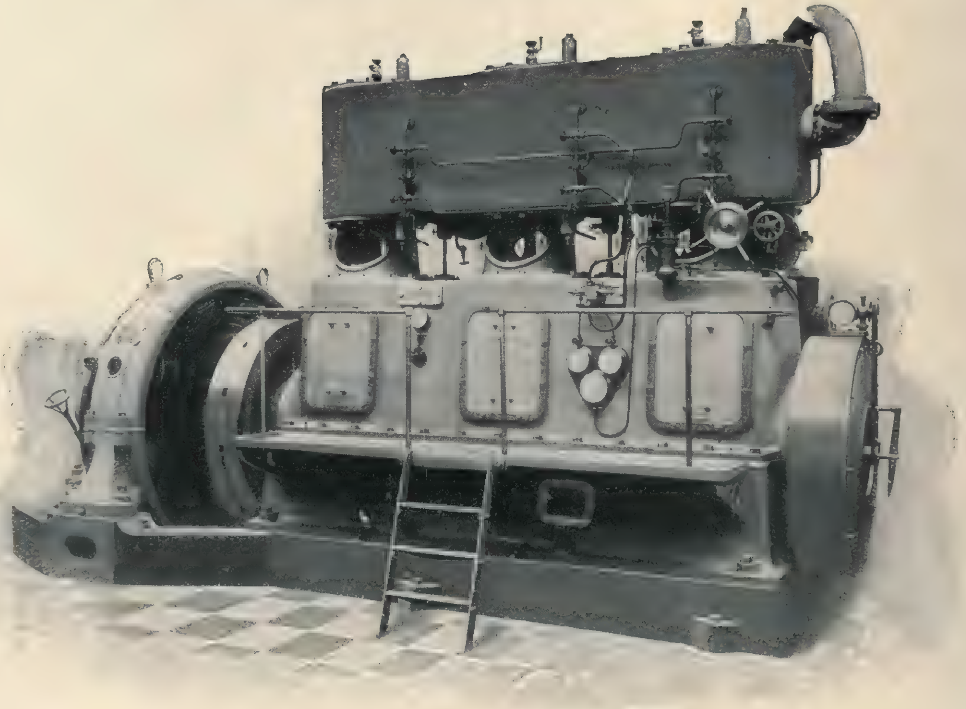

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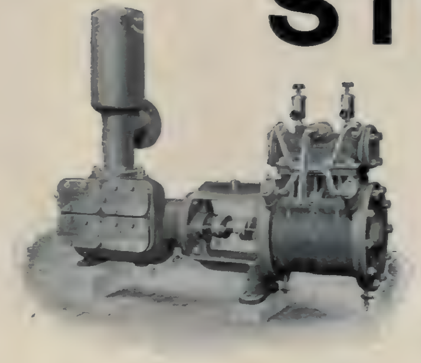

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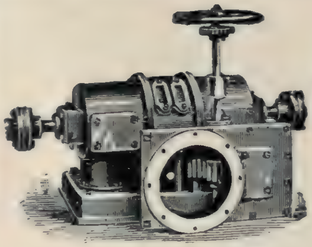

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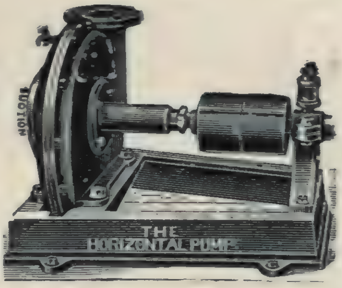

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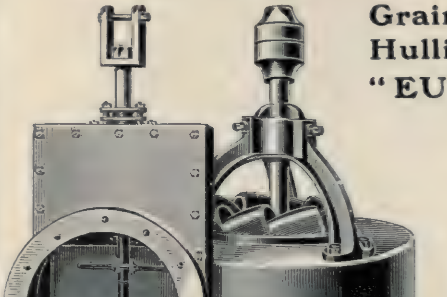

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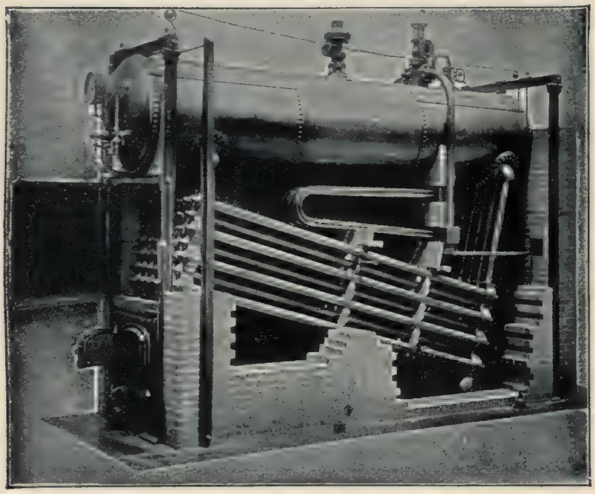

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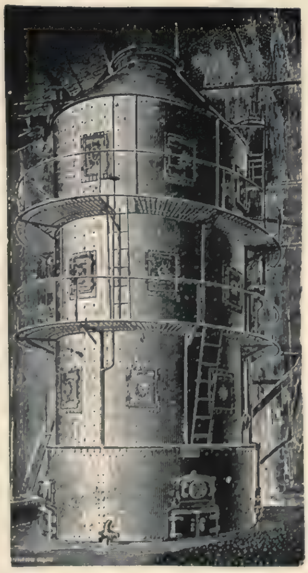

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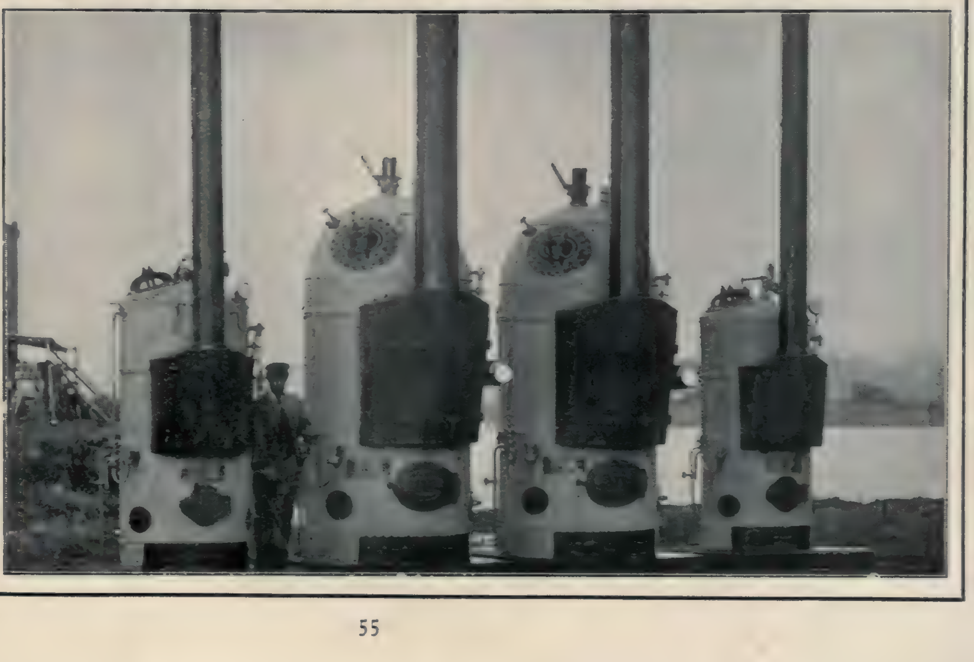

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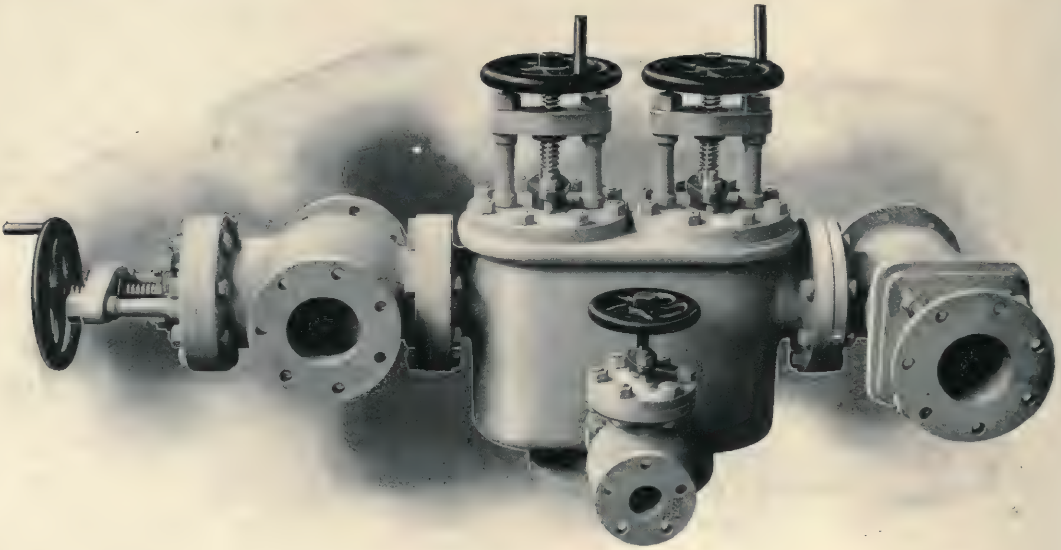

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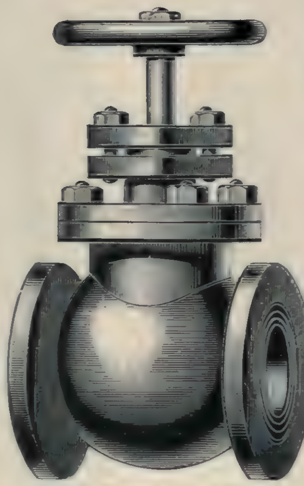

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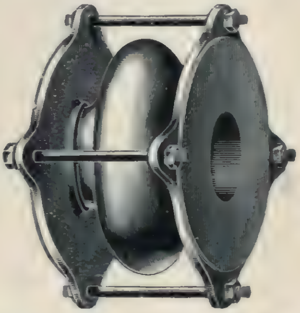

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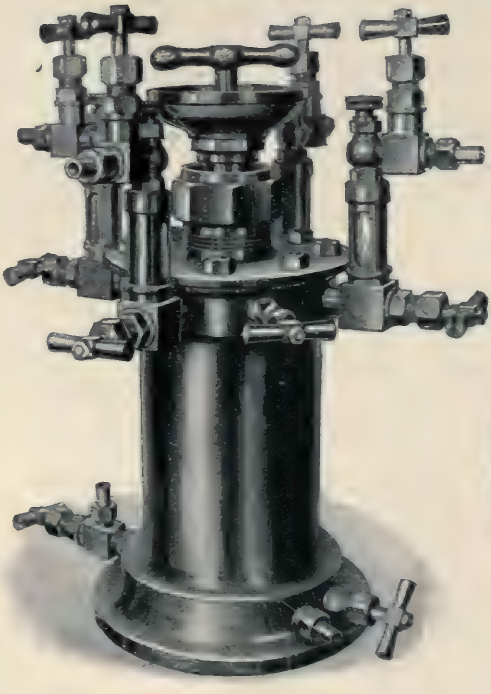

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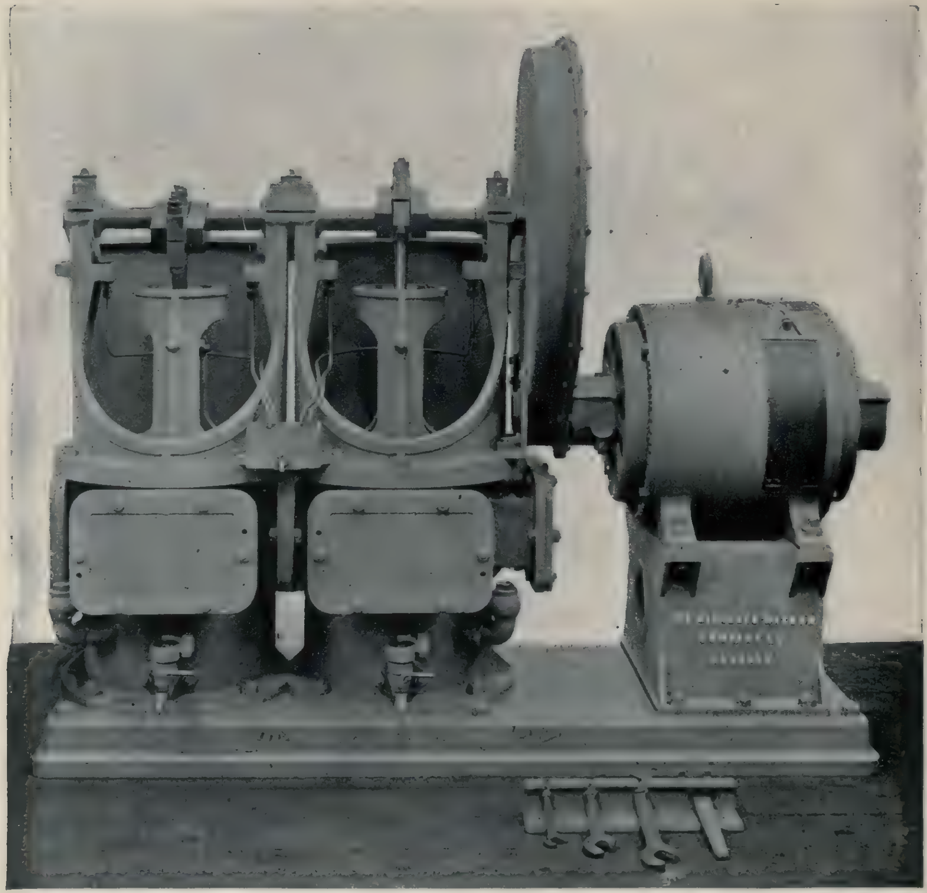

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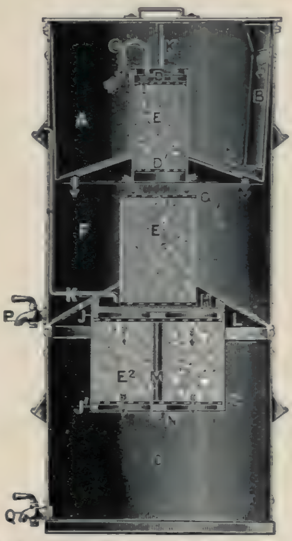

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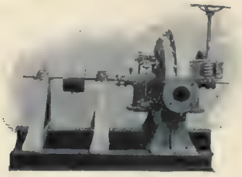

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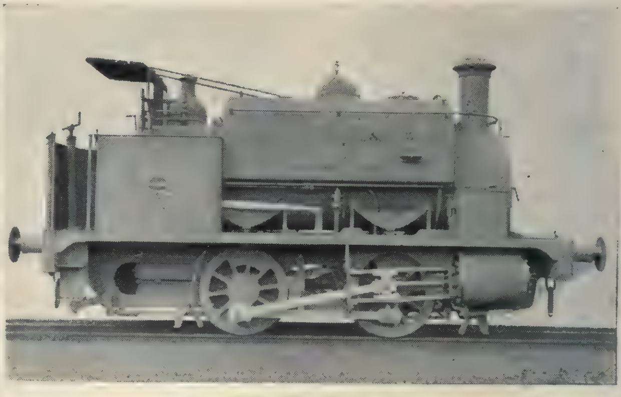

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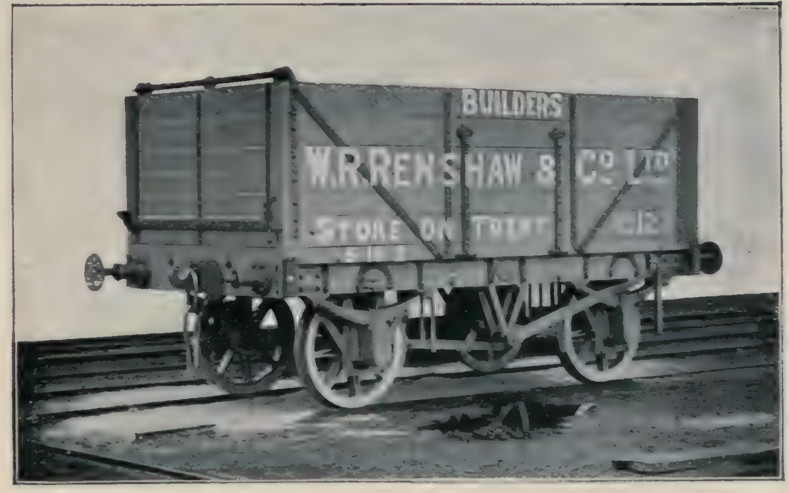

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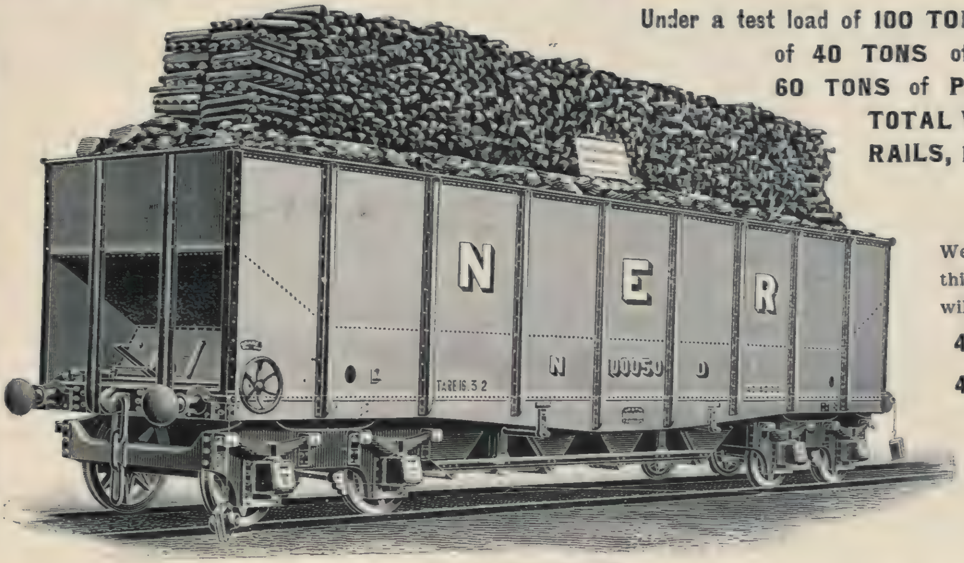

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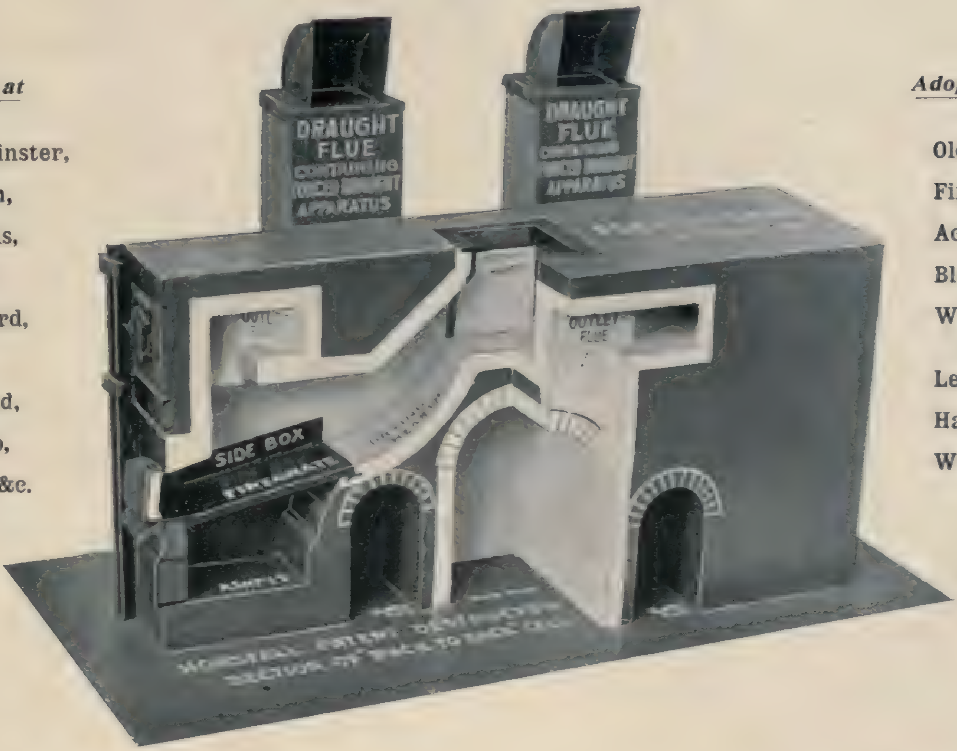

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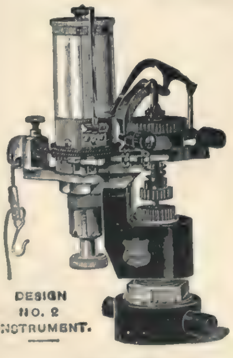

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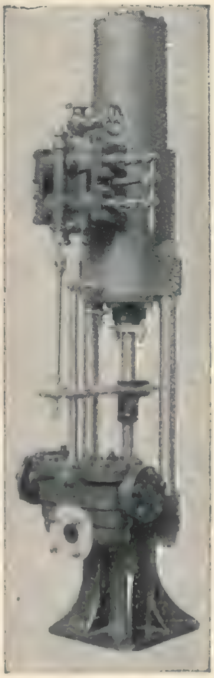

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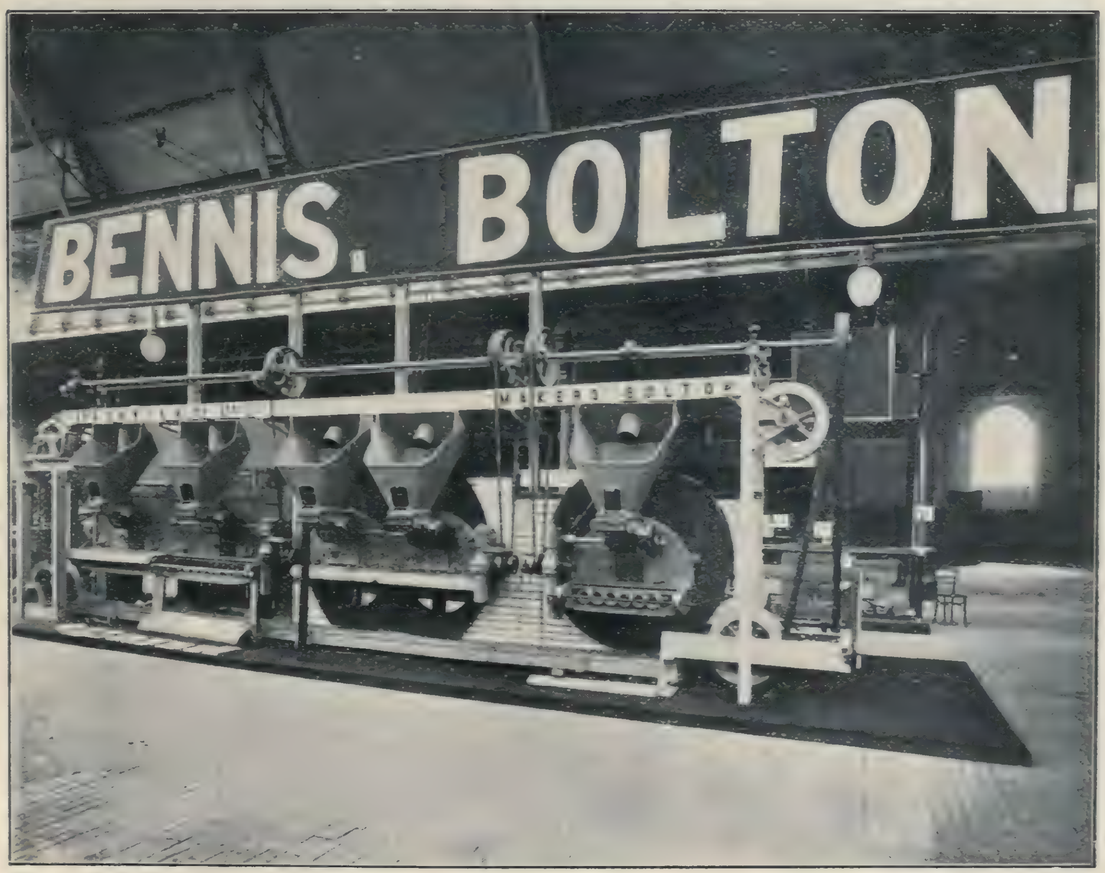

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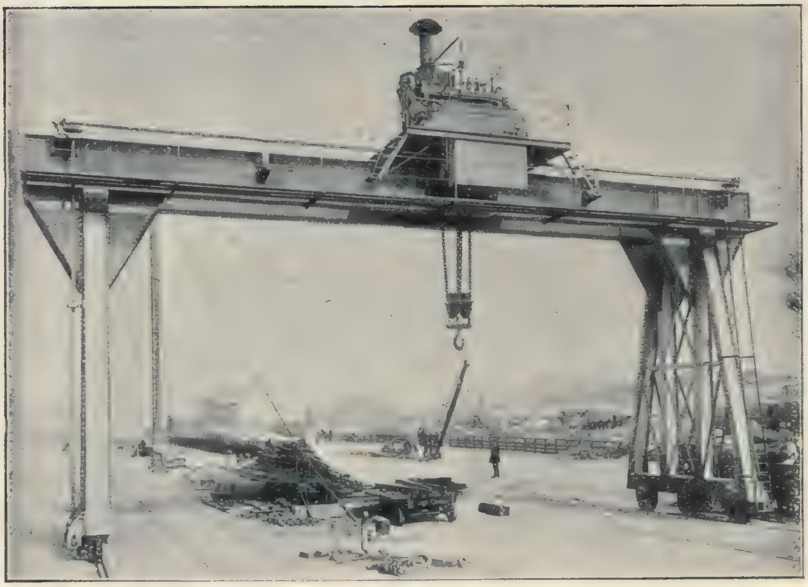

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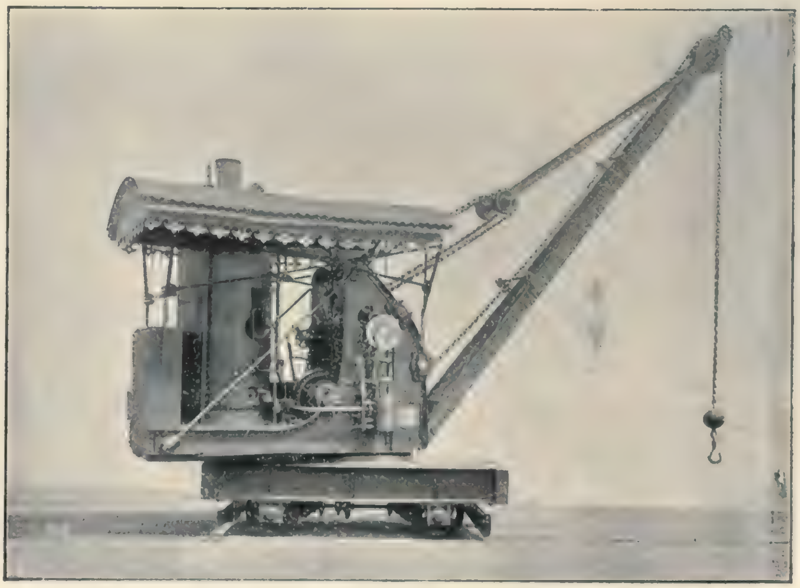

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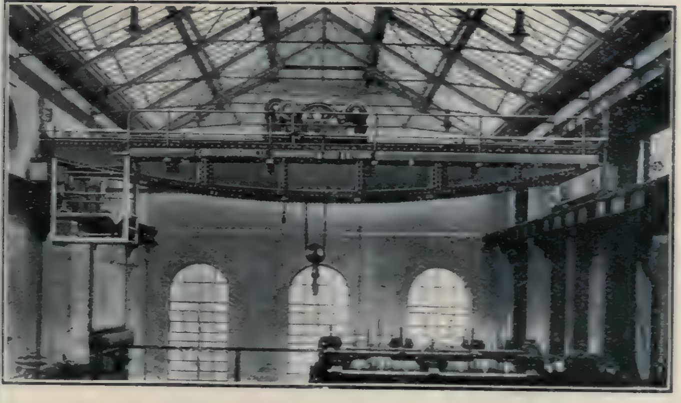

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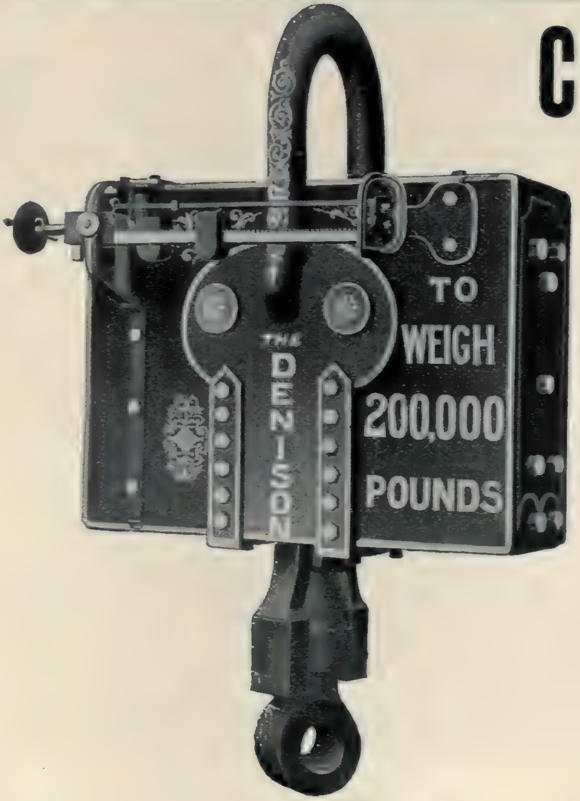

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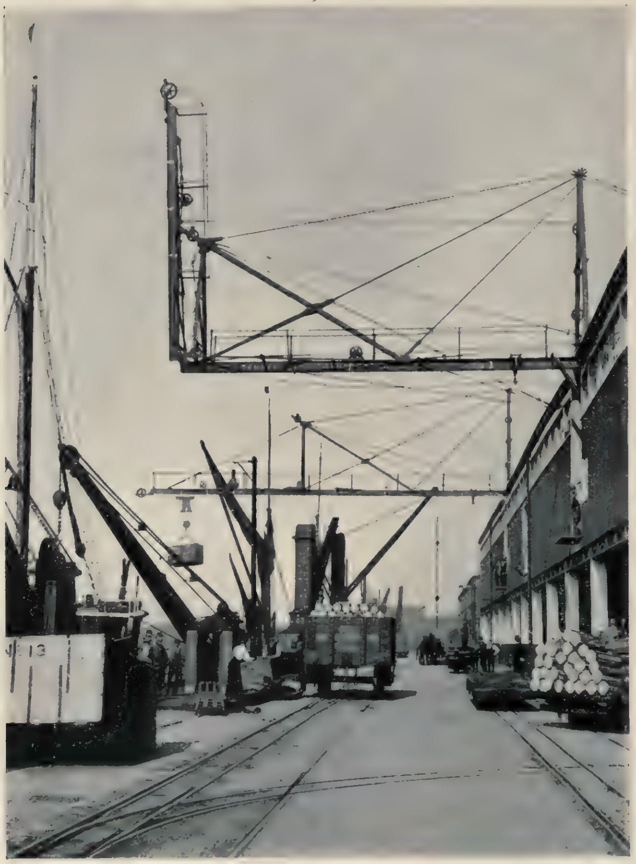

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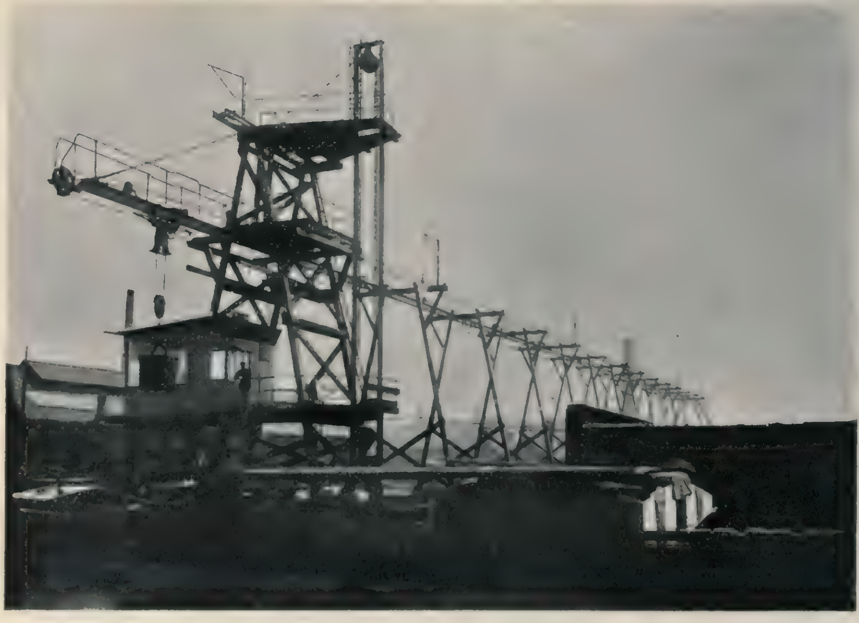

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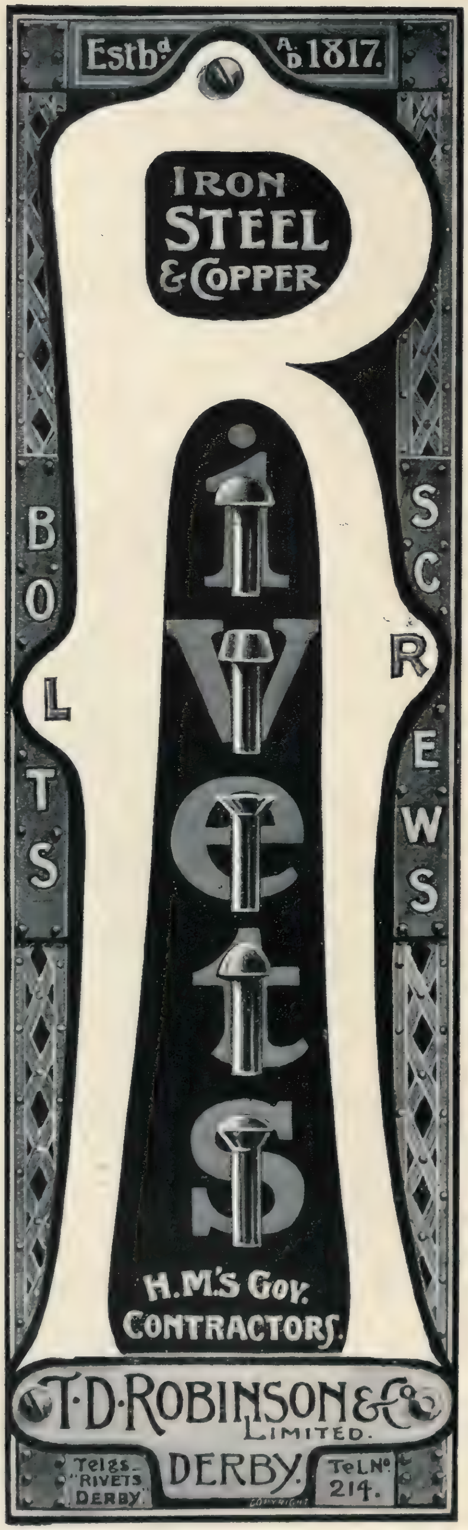
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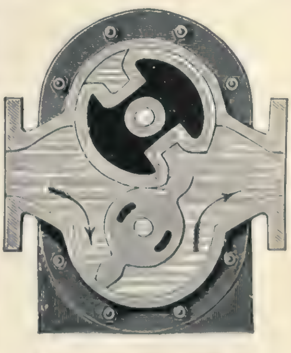

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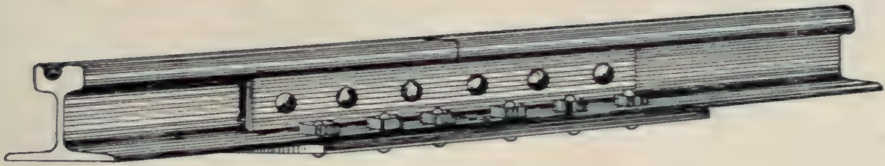

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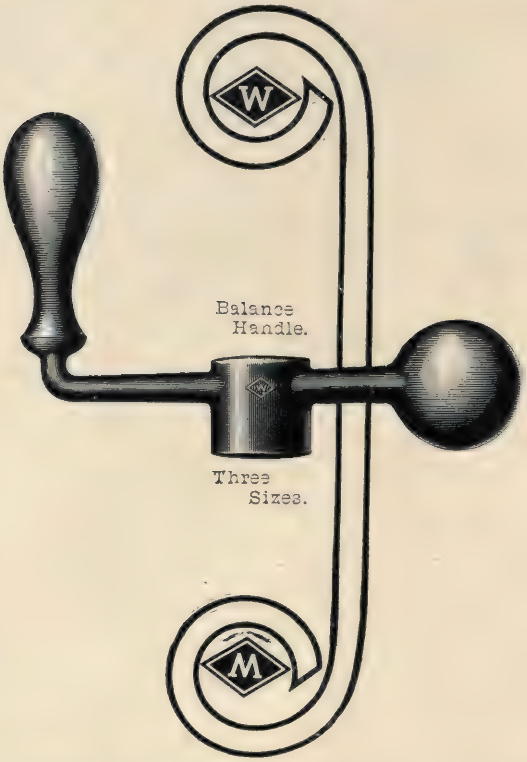
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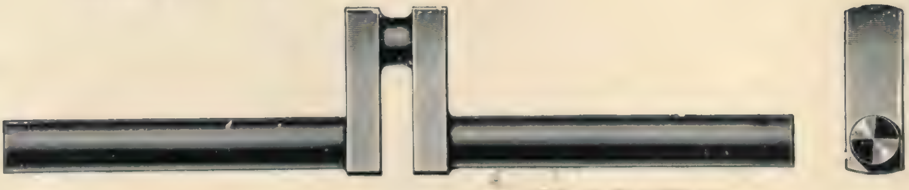

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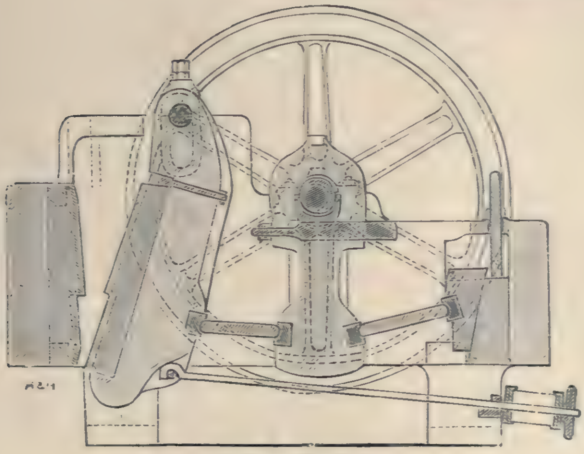

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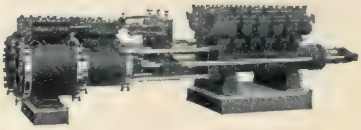

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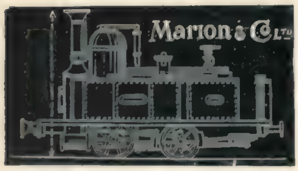
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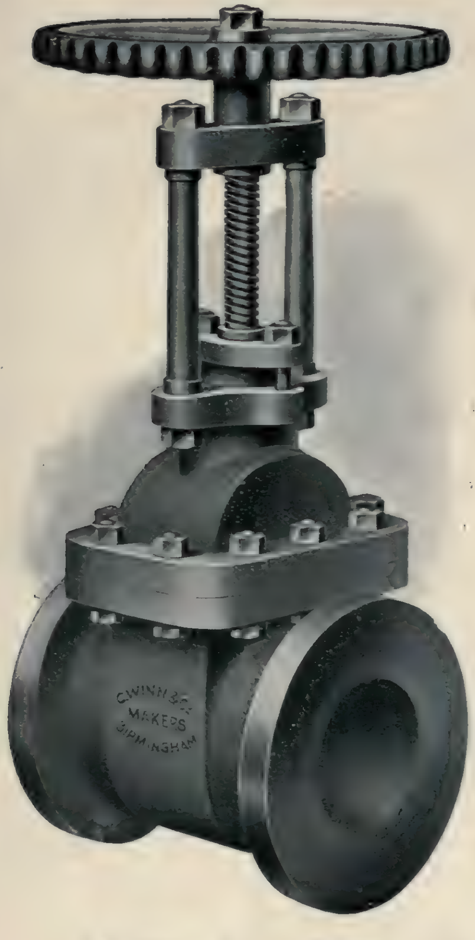

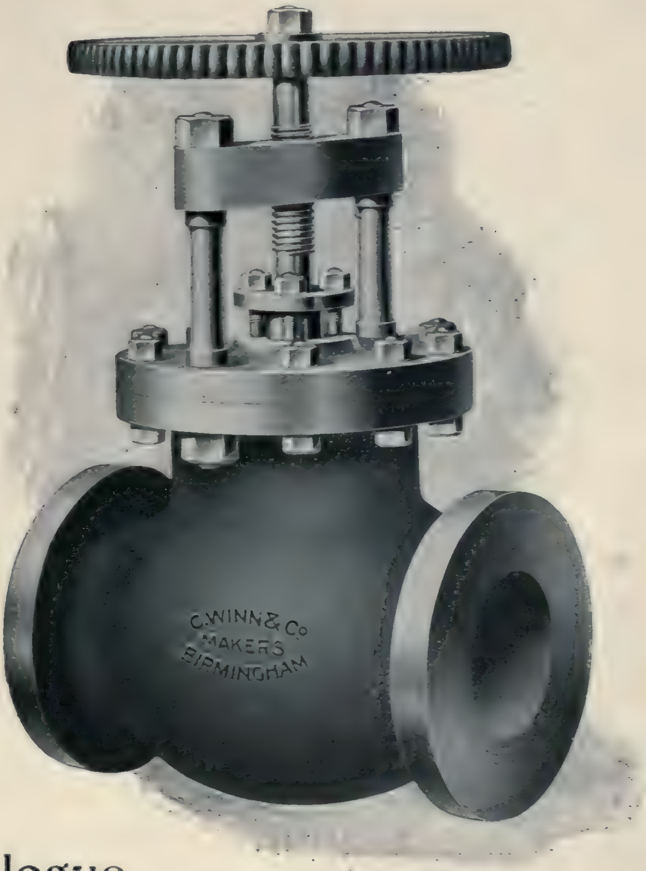

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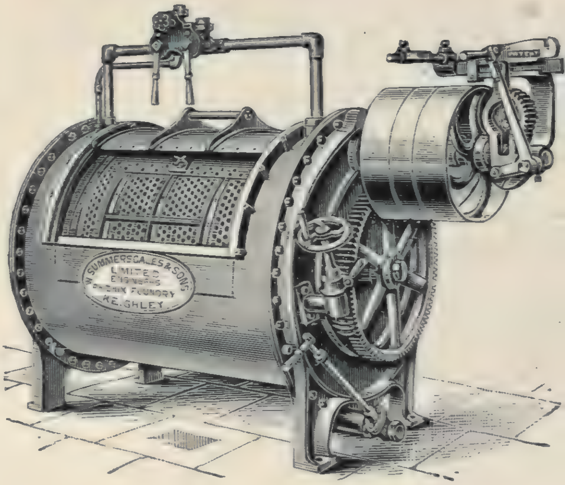

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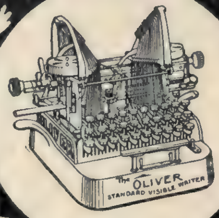

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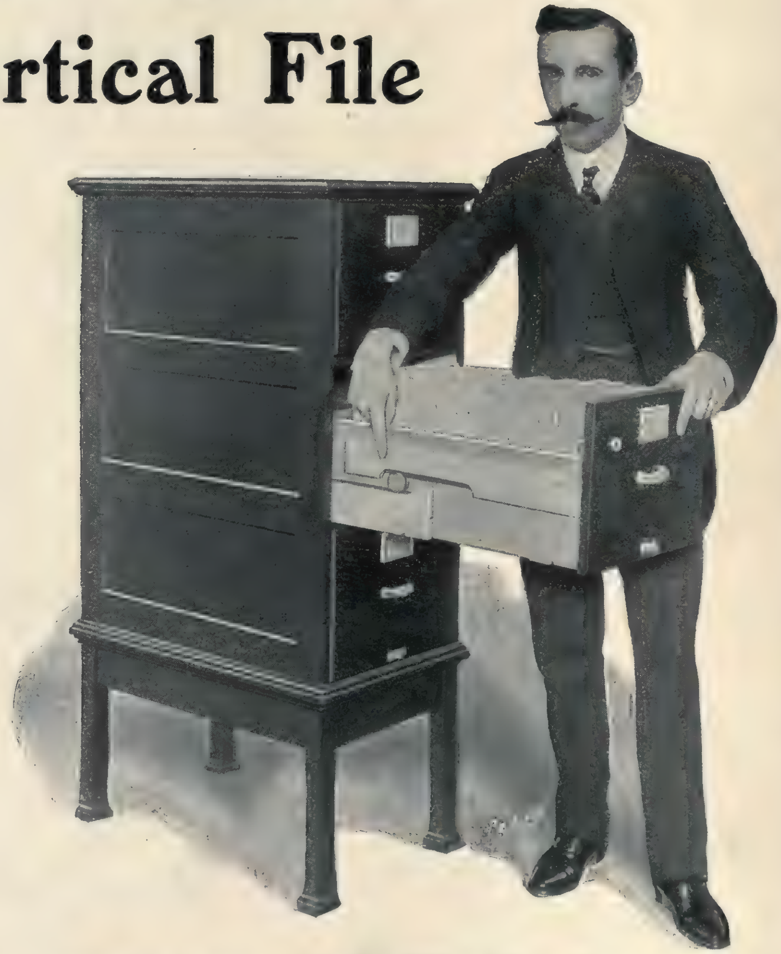

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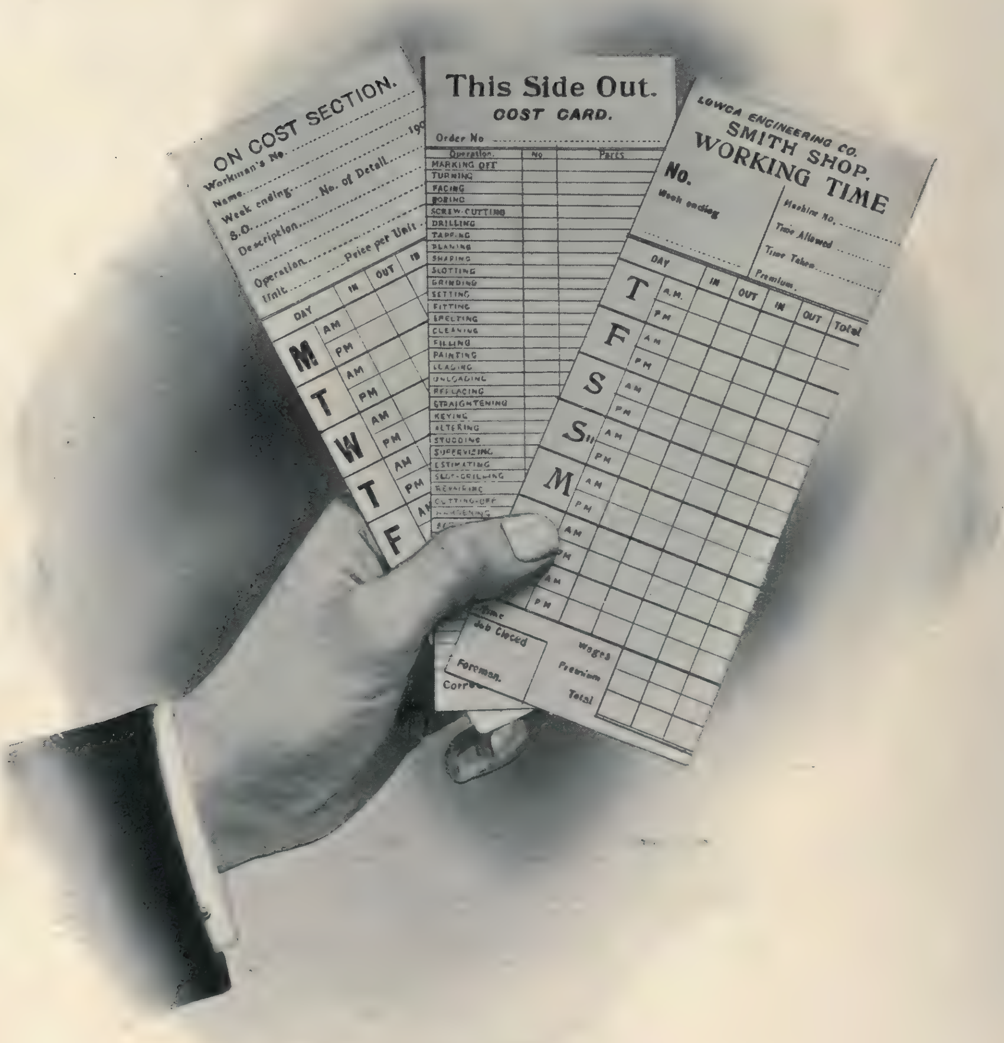

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Time Taken ....
Premium.

DAY		IN	OUT	IN	OUT	Total
T	A.M.					
	PM					
F	AM					
	PM					
S	AM					
	PM					
Su	AM					
	PM					
M	AM					
	PM					
	AM					
	PM					
	AM					
	PM					

Time Job Closed
Foreman.
Wages
Premium
Total

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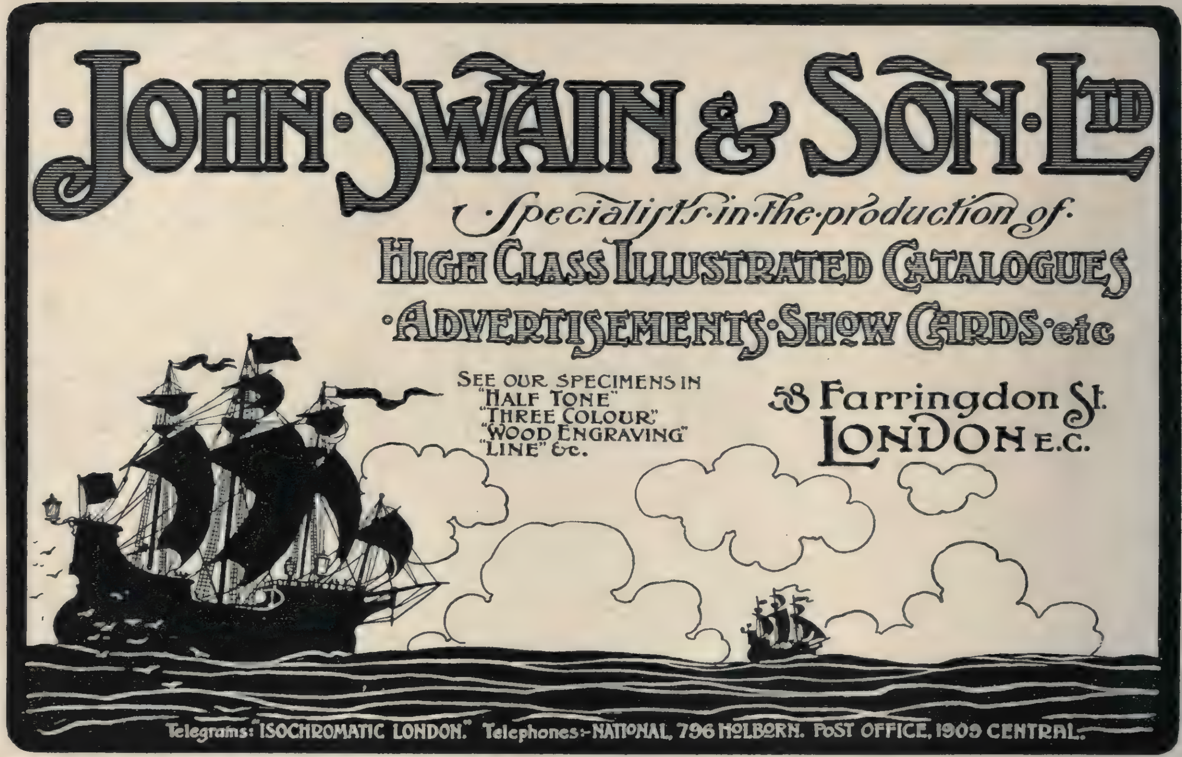

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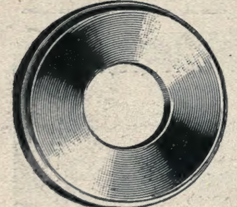

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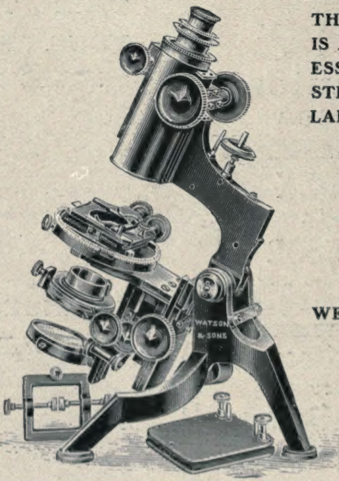

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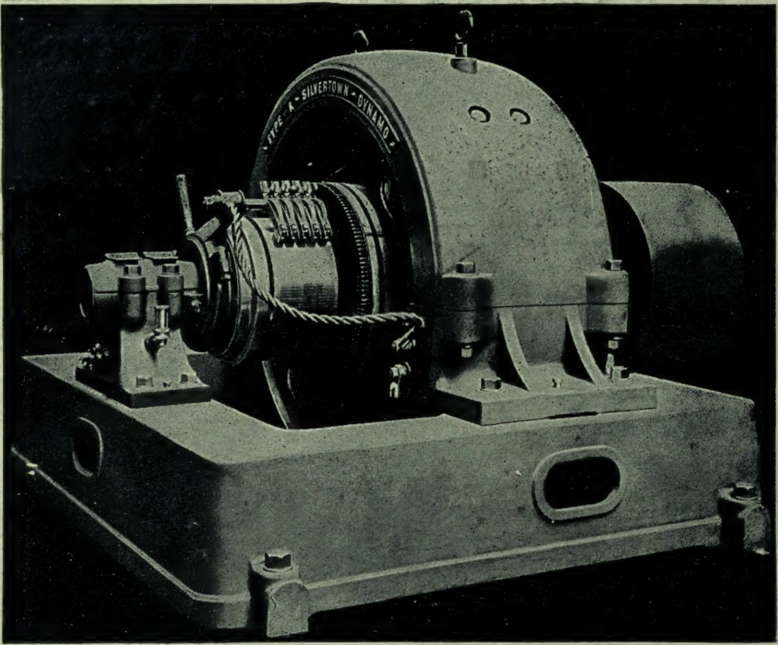

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